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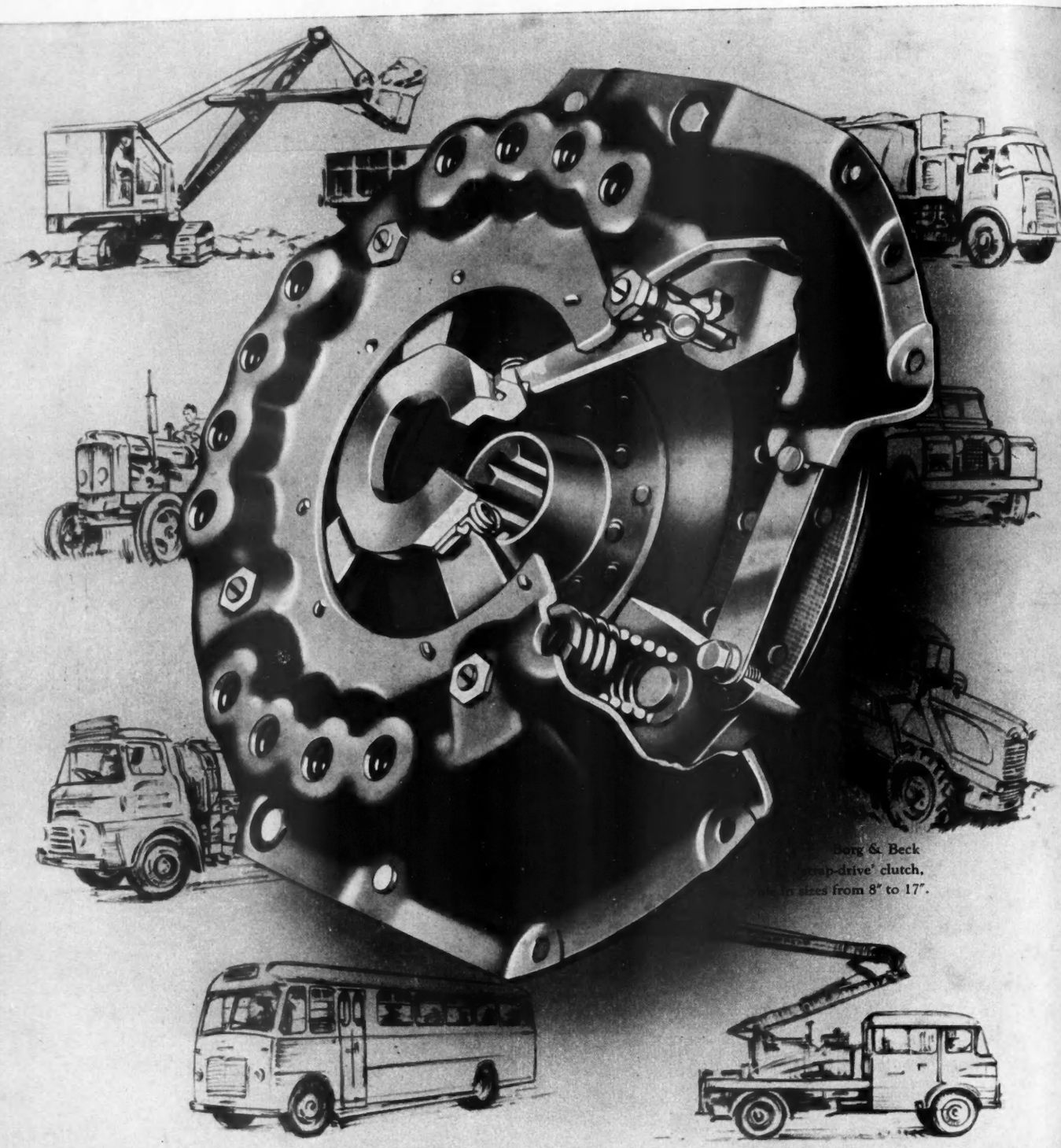

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Loading a large cast steel valve body, made by a high pressure process, on to a shot blasting table for removal of the headers. Highly developed techniques are necessary to obtain castings to the exacting requirements of the oil industry. (*Nurnberg photograph for* ENGINEERING)

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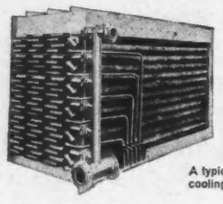

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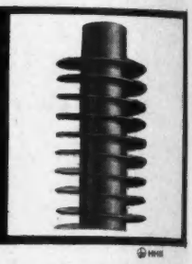

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ENGINEERING Impact

of Ups and Downs of Income and Expenditure

CHANGES in the pattern of industry in Britain, and in the manner in which money is spent, can be deduced from the latest issue of the Government Blue Book on national income and expenditure. It covers the eleven years from 1950 to 1960. Which of the trends disclosed will continue in the 1960's?

The chemical and allied industries achieved the greatest increase in output—an increase of 81 per cent, as measured by "the index numbers of output at 1954 cost." Gas, electricity and water came second, with an increase of 66 per cent, which was probably due chiefly to the rise in the consumption of electricity, which is usually reckoned to amount to a doubling every ten years. Engineering and allied industries were third, with an increase of 52 per cent.

Wage and salary figures show that in the vehicle industry the total expenditure on salaries more than trebled over the eleven years, and total wages went up nearly as much. In chemical and allied industries the figures are evidence of the remarkable ability of these industries to raise output (by 81 per cent) while the total spent on wages—allowing for inflation and the general rise in the standard of living—rose only slightly. That this was done by spending more on scientists, engineers and the like is apparent from the comparatively greater rise in that sector.

Looking at consumers' expenditure, the most substantial increases were in "motor cars and motorcycles, new and secondhand" (from £64 million in 1950 to £586 million in 1960), and in "radio, electrical and other durable goods" (from £170 million to £400 million). The latter category was actually highest in 1959, at £436 million.

Industry's estimates of capital expenditure in 1961 and 1962, published this week, throw more light on these Blue Book figures. Motor-vehicle manufacturers have made significant downward revisions in their estimated investment for this year. And in the iron and steel industry in 1962, companies expect to spend considerably less than the very large sums being spent this year. The chemical industry, however, plans to increase its expenditure.

Doubting the Value of Craft Skills

HITHERTO the training given to a youth in his apprenticeship has represented, even at best, the current practice of that period. He has been enabled to repeat and perpetuate the successes, and some of the faults, of previous generations. Such training had perforce to last him a lifetime, almost always without formal retraining. Our present apprentices will continue their working careers until well after AD 2000, and will see vast changes.

This was the opening thought in Mr. Hugh A. Warren's paper, which dealt with the changing profile of apprenticeship training, presented at the recent conference of the British Association for Commercial and Industrial Education (BACIE), held at the University of Nottingham. Entitled "Continental Comparisons," the conference sought to examine and compare education and training on the Continent of Europe with particular reference to the effects of economic integration.

"Progress is now so rapid," continued Mr. Warren, "that the once-for-a-generation pattern of education and training is already obsolete." We should not of course try and resist change simply to preserve a craft which, however admirable, is in fact dying. "Each example of a human skill still used in industry is a challenge to the engineer and the economist to use their technology and finance to replace it by more productive methods.

"We live in an age, therefore, that still needs to take training for skill very seriously, and yet *per contra* should ever be on the lookout for ways and means of rendering such skills redundant. It may well happen that a skill may become redundant during the working life of the apprentice. Unless his early training and education have provided for this he will naturally enough resist such change—just at a time when, taking the nation as a whole, it is good economics to replace or mechanize this particular skill."

A Top Test of Success

UNTIL recently, the only way to gauge the success of a firm was to compare its achievements with those of other firms engaged in the same industry. Out of several examples of a given type of product made by different firms, it could be that none is produced at a competitive price, without anyone realizing it.

But with the competition of the European Common Market just around the corner, there is a current need for some kind of comparison at a stage in advance of the finished product. The method now being successfully applied is to compare certain key efficiency figures with those of other firms, while respecting their confidential nature. Two years ago the British Institute of Management and the British Productivity Council set up a joint organization, the Centre for Interfirm Comparison (IFC), to assist firms in Britain to make comparative checks of this type.

A report by the Centre recently published shows that in one industry out of the twenty who have co-operated, the time taken to produce a virtually standard product shows a variation of as much as 2½ to 1. It follows that some firms have a tremendous scope for improving performance.

Investigations of this kind are beneficial to the firms participating, and could in the long run improve the whole national economy; but it is understandable that certain concerns, especially those who suspect that their efficiency is below par, might be reluctant to co-operate. Not only would such firms stand to lose the value of such comparison as IFC affords, but in turn the Centre's results might not be truly representative. Ample assurance is therefore given by the Centre that a firm's figures remain confidential.

IFC say it is becoming more and more clear that the "top test" must be profit on capital employed, and that this yardstick must be based on a measurement of real asset values in current monetary terms. They have found that there are figures reflecting such asset values which firms can contribute without difficulty, and without having to re-value each individual asset.

of Tempting Terms from the Irish Republic

THE measures taken by the Irish Government over the past decade to encourage foreign industries to settle in the Republic are beginning to reap rewards. Industrial employment has trebled in that time. Since 1955, 103 factories have been or are being constructed, and one third of this expansion is due to British industry.

The prospects for investment by Great Britain are perhaps better than for any other country, due to the interrelated banking system and the comparatively small distance between the two countries, which is an important consideration if the manufactured goods are to be exported.

Some of the special advantages which result in setting up new industries in Ireland include factory building grants. The Irish Government provide outright non-repayable grants up to the full cost of factory buildings, and in some cases up to 50 per cent of the cost of plant and machinery, with additional grants for the cost of training workers. The magnitude of these grants, however, depends on the geographical position of the site and whether another industry is already in the vicinity. Due to the lack of industry in the West, the grants tend to be more generous. There are further grants giving freedom from tax on export profits, and investors will be guaranteed free transfer, in their own currency, of dividends, interest and profits. Capital can be repatriated at any time.

Labour in Ireland is plentiful, and unemployment is still comparatively high at 6¼ per cent. The rapid emigration drift, which brought a decline in the population, has recently been checked—this makes it even more important to encourage further industrial expansion to benefit the Irish economy. Although 40 per cent of the population is employed on the land, the added benefits offered by industry have enthused the average Irishman to transfer from agriculture to industry, with better pay and a fixed working-hours week.

Prejudice Against Timber

TOO many prospective building owners think timber a low-grade material—a material suitable only for hutting. Engineers are frightened by its variability and their ignorance of it. Architects scorn it for all but their smallest jobs. Both are shy of its large-scale use.

Thus spoke Mr. R. J. M. Sutherland in his paper opening the First International Conference on Timber Engineering. The conference, sponsored jointly by the Timber Development Association and the University of Southampton, is being held this week in the Engineering Department of the University. It is believed to be the first international conference arranged to discuss timber as a structural material.

The theme of the conference is timber roof construction. There are 18 papers following that of Mr. Sutherland. All of them aim to kill the prejudice against timber by transforming the subject from a traditional craft to a 20th century technology.

As a theme, "roofing" has given ample opportunity for timber technology to be discussed in the widest sense. There are practical papers and there are research and theoretical papers. Nailing and gluing occupy the attention of the delegates for much of the time, from the point of view of the fabricator and in relation to the research problem of distributing the load within the components of a joint. At long last the fire bogy is dead.

Timber technology is a new subject, at least for Great Britain. One of its attractions is that its exponents—a relatively small number of men—are intimately involved in research, design and manufacture. What is most required is a language that will bridge the gap between the modern timber engineer and the traditional craftsman. Then timber will no longer be the Cinderella of the structural materials.

Moving People Underground

WHEN ground space becomes too restricted to permit the desired size of building to be constructed, the planners answer is to build higher. To combat congestion on the roads, London Transport are urging going lower—by the construction of more Underground lines; in particular the Victoria Tube that has been under discussion for so long. The arguments are put forward in their annual report for 1960.

Each year London Transport take a census on a single day in July of the number of passenger road vehicles of different types entering Central London between 7 am and 10 am. Such one-off figures may mislead when used in marginal comparisons, as they can so easily be affected by weather or events, but the changes from year to year facilitate a general comparison. For instance, in the last check there were 500 fewer buses and coaches entering in 1960 than in 1959, but 3,800 more cars and 3,000 more motor cycles and scooters—the last an increase of no less than 18·4 per cent. Pedal cycles, however, fell by 1,000.

The percentage rise in cars (6·6) follows closely the total growth of 10 per cent in car ownership and 6 per cent in car traffic generally. The difficulty for London Transport is that several cars are needed to carry as many people as one bus. Had the number of people coming into London diminished this would have been acceptable, but the total entering has in fact increased: from 1,202,000 in 1954 to 1,296,000 in 1960, painting a gloomy picture of road congestion in the future.

This increase has not been entirely by road; both British Railways and L.T. Railways show an increase in numbers handled, especially where modernization schemes have been carried out. This is a hopeful development, and since the staff position on the buses seems to be becoming ever more difficult, and more and more people will be coming to work in the huge office blocks now being completed, the only logical answer is more and better railways, preferably underground.

Theory and Use of Thermostatic Bimetals

As the general properties of thermostatic bimetals become more widely appreciated and the range of materials increases, designers will take more advantage of them in wider domestic and industrial use.

By P. Martin and N. Yarworth,
Telcon Metals Limited, Crawley

THERMOSTATIC bimetal may be defined as a composite metal comprising two or more layers with different thermal expansion coefficients. Such a metal, when heated will bend into the arc of a circle if initially flat, or change its curvature according to definite physical laws. The thermal bending equation for a bimetal strip may be stated as follows:—

$$\frac{1}{R} = \frac{6(\alpha - \beta)(m+1)^2(T - To)}{t\left[3(1+m^2) + (mn+1)\left(m^2 + \frac{1}{mn}\right)\right]} \quad . \quad (1)$$

where R = radius of curvature of the heated strip
α and β are the coefficients of expansion of the high and low expansion components respectively
n = ratio of the component moduli of elasticity
m = ratio of the component thicknesses
t = thickness of the composite strip
To = temperature at which the strip is flat
T = temperature to which the strip is heated.

Investigation shows that the maximum thermal activity occurs when $m = n = 1$ when equation (1) simplifies to

$$\frac{1}{R} = \frac{3}{2}(\alpha - \beta)(T - To) \quad . \quad . \quad (2)$$

Thus a range of bimetals can be produced by varying the expansivities of their component alloys.

In the majority of bimetals manufactured, the high expansion components consist of nickel-iron alloys containing 14 to 25 per cent nickel with chromium or manganese additions. Such alloys show little variations in their coefficients of expansion with temperature. The low expansion alloys, however, generally of the Invar type containing 36 to 50 per cent nickel, have expansion characteristics which vary considerably with temperature. In this range of alloys, the higher the nickel content the higher the temperature at which the coefficient of expansion begins to increase above the minimum value and the higher this minimum value becomes. Fig. 1 indicates the effect on thermal activity of varying the low expansion component in combination with a common high expansion alloy. It will be noted that type 400 has a lower deflection constant than type 140 but is more sensibly constant up to higher temperatures. This is achieved by using a higher nickel content low expansion component than that used for type 140.

Other factors such as electrical resistivity, corrosion resistance and magnetic permeability also affect the choice of component alloys. Table I lists the general properties of a range of the more widely used bimetals manufactured by the authors' company.

It is possible to derive working equations which may be used in initial design calculations for certain forms of bimetal elements by using equation (2) in conjunction with the relevant equations from mechanics. The most generally used are the equations for the cantilever, simple beam, "U" shape, spiral and helical coils. These are summarized in Table II, so that by reference to Table I, the approximate performance of a standard type of element using one of the listed bimetals can be predicted. Which form of element should be used in a given application is determined mainly by the space available and whether linear or rotational movement is required.

The main fields of application for thermostatic bimetals at present may be sectionalized as follows:—

Temperature Indication.—The rotation of a bimetal helical or spiral coil can be utilized to drive directly a pointer moving over a scale. Such a device presents a very simple, cheap and robust thermometer. These instruments can be easily read and are therefore widely used in both domestic and industrial applications.

Control.—The temperature-sensitive movement of bimetal elements can be used in numerous ways to control a given system. The simple thermostat consists essentially of a bimetal blade actuating a switch in the heating current supply, so that heating power is controlled in response to variations of temperature. Similarly, the damper of a boiler stove can be opened and closed automatically in response to variations in water temperature. Automatic control of the circulation of water in a car engine and radiator, and automatic control of the choke depending on the engine temperature can be readily effected.

TABLE I:—*Properties of some Typical Thermostatic Bimetals*

Bimetal type	Strip deflection constant (Ks)	Strip force constant (Fs)	Coil deflection constant (Kc)	Coil force constant (Fc)	Range of maximum sensitivity (° C)	Useful deflection range (° C)	Electrical resistivity at 20° C (microhm-cm)	Characteristics
200	$19{\cdot}9 \times 10^{-6}$	$4{\cdot}8 \times 10^{6}$	$23{\cdot}5 \times 10^{-4}$	$2{\cdot}9 \times 10^{4}$	10 to 175	−75 to 260	109	Very high deflection and resistivity
140	$14{\cdot}0 \times 10^{-6}$	$6{\cdot}7 \times 10^{6}$	$18{\cdot}9 \times 10^{-4}$	$3{\cdot}6 \times 10^{4}$	20 to 200	−70 to 350	76	High deflection
400	$12{\cdot}0 \times 10^{-6}$	$6{\cdot}7 \times 10^{6}$	$16{\cdot}2 \times 10^{-4}$	$3{\cdot}6 \times 10^{4}$	70 to 300	−70 to 400	70	High linear deflection range
15	$9{\cdot}5 \times 10^{-6}$	$6{\cdot}7 \times 10^{6}$	$12{\cdot}8 \times 10^{-4}$	$3{\cdot}6 \times 10^{4}$	20 to 120	−70 to 220	17	Low Electrical resistivity
75	$6{\cdot}8 \times 10^{-6}$	$6{\cdot}7 \times 10^{6}$	$9{\cdot}2 \times 10^{-4}$	$3{\cdot}6 \times 10^{4}$	150 to 300	−70 to 500	57	Moderate deflection linear to high Temperature
38	$3{\cdot}8 \times 10^{-6}$	$6{\cdot}7 \times 10^{6}$	$5{\cdot}1 \times 10^{-4}$	$3{\cdot}6 \times 10^{4}$	20 to 250	−70 to 500	56	Low deflection
188	$9{\cdot}0 \times 10^{-6}$	$6{\cdot}2 \times 10^{6}$	$12{\cdot}2 \times 10^{-4}$	$3{\cdot}3 \times 10^{4}$	10 to 150	−70 to 500	93	Corrosion-resistant
131	$13{\cdot}3 \times 10^{-6}$	$4{\cdot}7 \times 10^{6}$	$18{\cdot}0 \times 10^{-4}$	$2{\cdot}6 \times 10^{4}$	10 to 120	−75 to 150	18	Brass—invar low resistivity
11	$8{\cdot}4 \times 10^{-6}$	$6{\cdot}2 \times 10^{6}$	$11{\cdot}3 \times 10^{-4}$	$3{\cdot}3 \times 10^{4}$	10 to 150	−70 to 350	20	High magnetic permeability

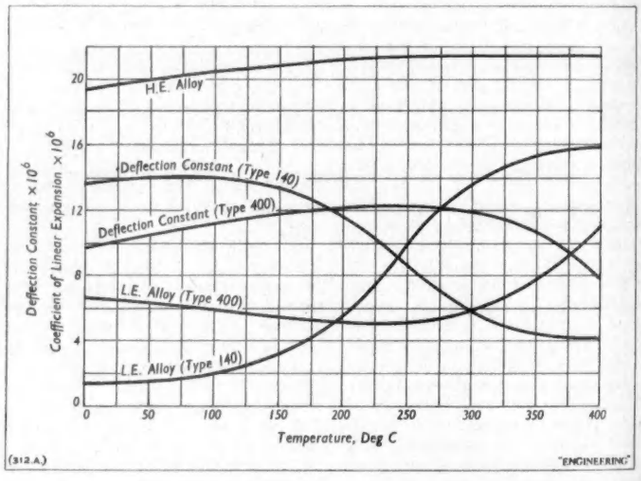
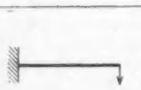
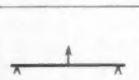
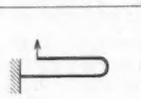
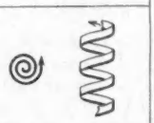


Fig. 1 The effect on thermal activity of varying the low expansion component in combination with a common high expansion alloy.

TABLE II:—*Summary of Formulae.*

Cantilever	Simple Beam	U-Shape	Spiral and Helical Coils
			
$B = \frac{K_S(\Delta T)L^2}{t}$	$B = \frac{K_S(\Delta T)L^2}{4t}$	$B = \frac{K_S(\Delta T)L^2}{2t}$	$A = \frac{K_C(\Delta T)L}{t}$
$F = \frac{F_S B wt^3}{L^3}$	$F = \frac{16F_S B wt^3}{L^3}$	$F = \frac{4F_S B wt^3}{L^3}$	$F = \frac{F_C A wt^3}{Lr}$
$P = \frac{F_S K_S(\Delta T)wt^2}{L}$	$P = \frac{4F_S K_S(\Delta T)wt^2}{L}$	$P = \frac{2F_S K_S(\Delta T)wt^2}{L}$	$P = \frac{F_C K_C(\Delta T)wt^2}{r}$

B = Deflection
A = Angular Deflection
F = Force
P = Restrained Force
w = Width
t = Thickness
L = Length
r = Radius (of Load Application)
ΔT = Temperature Change
K_C = Coil Deflection Constant
K_S = Strip Deflection Constant
F_C = Coil Force Constant
F_S = Strip Force Constant

Concluding **Thermostatic Bimetals**

Equipment and instrument protection can be achieved simply and economically by the use of a bimetal element acting directly or indirectly as a thermal overload switch.

Compensation.—An immediate application is to obviate the effects on equipment of changes in ambient temperature, as in the cold junction of a thermocouple and in the torque systems of moving coil instruments. Generally a change in ambient temperature causing a change in a given system can be corrected by the linear or rotational movement of a bimetal device causing an opposing electrical or mechanical effect as in the case of the bimetal device actuating a variable resistance or capacitor or acting directly as a thermal lever.

Thermo-Mechanical.—In this field the bimetal is used as an actuator. Electrical or heat energy is converted into mechanical energy by the movement and force exerted by the deflecting bimetal element. A typical example is the bimetal flasher unit which is widely used in advertising and in automobile direction indicators. Again such units are simple and cheaply produced and will undergo many millions of cycles of operation requiring little or no maintenance.

Although the major groups of applications are itemized for convenience, there is considerable overlapping of technical design consideration in the various fields. For example, a bimetal actuated voltage regulator as used in the automobile industry can be regarded as far as the bimetal function is concerned as exemplifying control, compensation or thermo-mechanical applications.

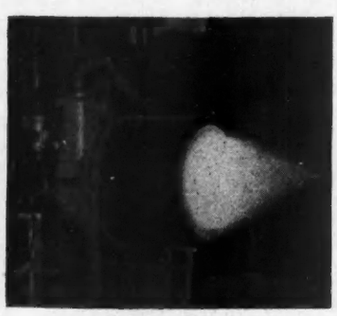
The authors are of the opinion that as the general properties of thermostatic bimetals become more widely appreciated and the range of materials increases, designers will take more advantage of them in wider domestic and industrial applications. In conclusion, they would like to thank the Directors of Telcon Metals Limited, for permission to publish this article.

Copies of the complete paper, of which the above is a digest, may be obtained free of charge from Telcon Metals Limited, Manor Royal, Crawley, Sussex.

Burner Consumes Waste and Residual Fuels

Thermal Vortex Burners, which are based on a Lummus Company design, are now being manufactured in this country by the Thermic Equipment and Engineering Company. They operate on a wide range of residual fuels and waste products including 3,500 sec Redwood and light oils, asphalts, Residium, acid sludges, solvents or any gases.

Heat releases are said to vary from 1,000,000 Btu per hr per cu. ft on heavy oils to 3,000,000



No external combustion chamber is required.

on gas or light oils. Eight standard models are available ranging in capacity from 1·3 to 48,000,000 Btu per hr per cu. ft.

The Vortex Burner consists essentially of an air swirl-vane assembly, burner barrel, controls and refractory lined combustion chamber. Combustion is said to be efficient, compact, rapid and clean, about 80 per cent occurring within the burner which results in a very short, whirling, hot flame (3,000° F).

The flame extends only a foot or two from the burner's mouth, thus no external combustion chamber or furnace is required. This short flame length and high flame velocity (about 100 ft per sec) improve convection heat transfer and stir up furnace gases making it particularly useful for oil stills and packaged direct fired air heaters which are designed to complement the burner. These air heaters are compact and incorporate refractory lining.

Conventional fuel and air pressures are used and normal use requires 5 per cent excess air.

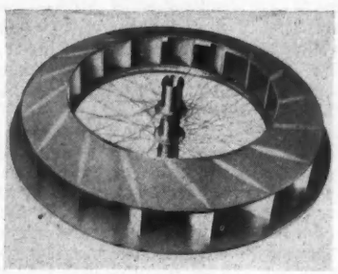
Thermic Equipment and Engineering Company Limited, Salmon Street, Preston, Lancs.
Licensee: Gibbons Brothers, Dudley, Worcs.

Lift Fans for Hovercraft

Hovercraft obtain their lift by a fan-generated air cushion. The general requirements for such a fan are low weight, flat head-flow characteristics, high efficiency, long life and low cost.

Dowty Rotol have developed a centrifugal impeller which is of glass fibre and steel construction with a spoked central wheel, thus giving it a light rigid structure. As well as being of low weight the glass fibre structure can be repaired. Erosion and stone damage to the blades is prevented by a light stainless steel sheath.

Dowty Rotol say that the evidence so far accumulated both during rig tests and under actual operating conditions confirms the fans'



Hovercraft lift fan 5 ft diameter and constructed from glass fibre and steel.

suitability for hovercraft applications. At present under construction are fans up to 12 ft diameter absorbing 1,500 hp and delivering 13,000 cu. ft per sec with heads ranging from 50 to 90 lb per sq. ft.

The characteristics of an impeller are designed to match a specific installation, but in general, efficiencies of the order of 80 per cent are readily obtainable by the use of the appropriate aerofoil blading and careful aerodynamic study. Wide variation in flow volume is possible with only a comparatively small change in head and efficiency. These features can have considerable influence on the stability of the hovercraft as a whole.

The fan in the illustration is 5 ft diameter and the two annular discs are fabricated using one piece contour woven Tyglas rings as reinforcement. There are six layers to each disc. The fan weighs 70 lb and absorbs 130 hp.

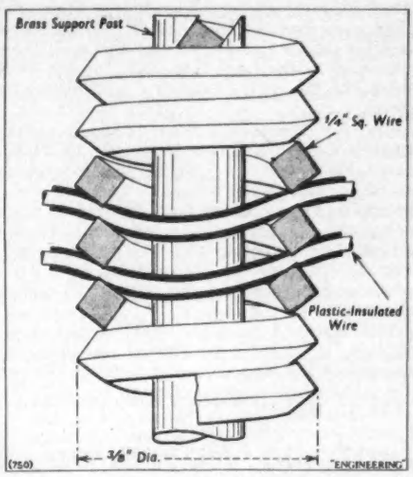
Dowty Rotol Limited, Staverton, Gloucestershire.

Coil Spring Type Wire Connector

A new type connector for connecting plastic-insulated small-gauge wires to terminal posts has been developed by Bell Telephone Laboratories. It is expected to supplant the binding post and nut arrangement which has been the standard method of connecting telephone wires to terminals.

The connector looks like a coil spring and is made of $\frac{1}{16}$ in square section tin-plated phosphor bronze wire. It is wound into a coil about $\frac{3}{8}$ in outside diameter. Passing through the centre is a brass post which supports the coil and attaches it to the terminal block.

When insulated wire is looped around the spring once, and pulled tight, the wire is forced between two turns of the coil. The sharp square edges of the connector bite through the plastic



The sharp edges of the connector bite through the insulation and make contacts with the wire.

insulation and make multiple contacts with the wire. The contacts are said to be both electrically stable and vibration proof. Other wires can be forced into other turns of the coil and any wire can be removed without disturbing others.

The connectors have been life-tested in reactive environments, such as hydrogen-sulphide, under changing temperature conditions. It was found that the wires themselves will fail before the electrical contacts are affected.

Bell Telephone Laboratories, 463 West Street, New York 14, USA.

Quick Action Oil Spillage Boom

A Norwegian oil spillage boom, now available in this country, is said to offer great advantages over others being used because of the speed with which it can be launched, its durability and its ease of use.

The boom is basically a series of linked units each consisting of a 20 cm diameter inflatable pvc hose closed at both ends. Each unit is 25 m long and is encased in a protective outer skin of pvc coated fabric. The pvc used is provided by British Geon Limited. When inflated, the series of double tubes rides on the surface of the sea and adjusts itself to the movement of the waves.

Hanging beneath the hose is a skirt 40 cm deep which prevents oil escaping under the boom. The skirt is ballasted with a built-in chain. To prevent oil lapping over the top of the boom, the outer skin protrudes to form a skin on top of the hose.

Units can be added to the boom very quickly. A CO_2 gas generating cylinder is attached to each length and the hose can be inflated in under 10 sec. Launching is said to be quick and easy. The boom is supplied in mobile launching cases in which five standard lengths of tube (125 m in all) are supplied ready coupled, and folded into tiers. The boom is said to be highly manoeuvrable and is easily guided into position from a boat, while a second operative remains on shore to open each CO_2 cylinder as it emerges from the launching case.

As yet agents have not been appointed in this country and inquiries should be sent to *Helly J. Hansen A/S, Moss, Norway.*

XUM

Eccentric Drums for Tyre Testing Rig

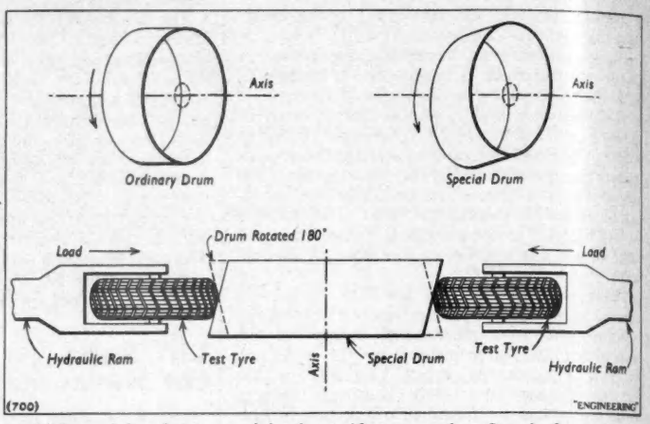
Eccentric steel drums are incorporated in three of five tyre testing plants recently built by Heenan and Froude for a Romanian factory.

The drums were designed to impose severe stresses on the walls of giant, large giant and earthmoving tyres, two of which may be tested simultaneously on each machine. Hydraulic rams force the tyres on to the drum, which as it revolves, because of its unusual contour, forces the tread of the tyres from side to side, thus subjecting the walls of the tyre to considerable strain.

The five Heenan machines, ordered by the Rustyfa consortium, consist of one 15,000 kg, two 5,000 kg and two 2,000 kg machines which are designated by the maximum load which can be applied to each of the tyres under test. Each of the three larger models is supplied with two drums, one eccentric and one conventional. The 2,000 kg models are supplied with conventional drums only and are intended for testing car tyres.

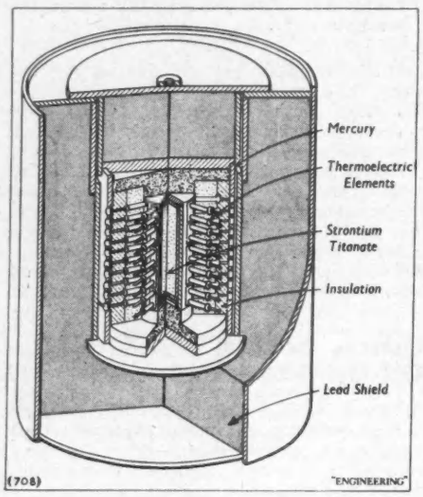
The 15,000 kg machine, which weighs about 60 tons, is designed for routine test duties at speeds ranging between 5 and 35 mph. Of the two 5,000 kg machines, which weigh about 15 tons each, one is intended for routine testing at speeds ranging from 15 to 45 mph and the other for development work at speeds between 5 and 80 mph. The two 2,000 kg machines weigh about 12 tons each. One is for routine testing at speeds between 5 and 50 mph and the other for development work at speeds between 5 and 80 mph.

Heenan and Froude Limited, Worcester.



Eccentric drums are used on this tyre testing rig. As the drum revolves, its contour forces the tread of the tyres from side to side, subjecting the tyre walls to considerable strain.

Isotope Powered Automatic Weather Station



Automatic weather station power source.

What is said to be the world's first isotope-powered, automatic weather station will soon be going into operation in the Canadian Arctic. This was announced by the Department of Transport of Canada, the US Atomic Energy Commission and the US Department of Commerce Weather Bureau.

Earlier difficulties created by the lack of a continuous power source have been eliminated by the use of isotope power.

The station and power source are housed in a cylindrical insulated container approximately 8 ft long, the lower 5 ft of which will be buried in the permanently frozen ground. Rugged meteorological instruments mounted as integral parts of the station will measure wind direction and speed, temperature and barometric pressure. These readings will be fed into a data processing system and will emerge ready to go directly to the transmitter, which in turn will relay them every three hours to the receiving stations. The anemometer and thermometer will be exposed on a tower beside the station while the barometer will be placed within the cylinder along with recording equipment, radio transmitters, antenna and other electrical apparatus.

The power source is located in a lower chamber of the container. Consisting of a strontium-90 heat generator and thermocouples, batteries, and a convertor, it uses an insoluble chemical form of the isotope strontium 90 securely locked in a corrosion-resistant capsule and shielded by $\frac{3}{4}$ ton of lead. The excess heat from the strontium 90 is used to maintain an interior operating temperature of approximately 70° F. This element produces thermal energy which when converted into electrical energy charges the nickel-cadmium storage battery system, which in turn activates the radio transmitter. The isotope strontium 90 has a relatively long half life and is capable of producing usable power for over ten years.

The weather station is said to be capable of functioning unattended for up to two years.

Square Mixer Reduces Mixing Time

What is claimed to be the first square mixer produced in Britain is now available. Known as the Turner-Heesen Ultra-Rapid square mixer, it employs the fundamental principles of dry material batch mixing.

The material being mixed is discharged from a worm along its entire length of vertical travel and is thrown against an angular shaped housing. The effect of this action is to create a turbulating movement, with the result that the whole of the machine's capacity is used as a mixing area.

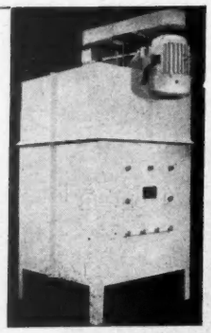
With normal mixing the material is conveyed up the worm and distributed at the top around the perimeter of the circular container. In the Turner-Heesen mixer, an additional action is provided by the patented tapered worm which causes material to fall away along its entire length with the collapse increasing towards the centre. In one of the illustrations the black arrows show the material flow in a conventional mixer and the white arrows the flow in the Turner-Heesen machine. The better distribution can easily be seen.

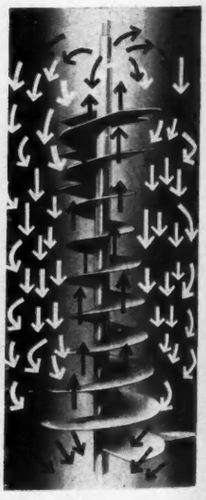
The makers say that tests with materials with a particle content of 1-400 of average humidity—provender for example—have shown that up to 5 tons of material can be mixed in under five minutes. With chemicals such as silicates, in which the particle content may be in the region of 1-100,000, tests produced an average mixing time of about 17 minutes. With other types of material—antibiotics, powdered milk and foods, raw plastics—the machine permits a homogeneous mix to be made in about one quarter of the standard mixing time.

Although the machine contains no hopper, rapid discharge of the mixed material results from the use of patented templates in the base. These templates in effect convert the machine from a square unit to a cone shaped container.

The mixers are available in $\frac{1}{2}$ to 5 ton capacities. Being square they are said to occupy less space than traditional mixers. For example, the 1 ton machine measures 8 ft 4 in by 4 ft 5 in. The 5 ton unit has two worms with the templates offset so that a continuous flow of material is obtained between the worms.

E. R. and F. Turner Limited, Foxall Works, Ipswich.





(Above) The Turner-Heesen ultra-rapid, square mixer, which because of its square design occupies less space than conventional mixers. (Right) The black arrows illustrate the path taken by material in a traditional mixer whilst the white arrows show the additional mixing activity obtained from the new machine by using a tapering worm and an angular shaped housing.

Plain Words

By Capricorn

At a demonstration in London last week of a large-screen television system (developed in Switzerland and described elsewhere in this issue), a medical doctor told a true story which will appeal to anyone with a scientific or technical background.

A general practitioner, he said, happened to read an article on the treatment of a coronary disease in one of the medical journals. He was much impressed by the article and the treatment it advocated, and he followed its advice. In the first year he achieved 78 per cent success in the curing of this disease among his patients. That was in 1935. In 1936 he achieved a similar success. Then he happened to read another article, which cast doubt on the treatment described in the first article. In 1937 his successes fell to 29 per cent.

Just because this story is about a doctor and his patients, it would be easy to say that it has no relevance to branches of science which have less of the human element in them. I would not agree with that view. It is just as necessary for an engineer or a scientist to have faith as it is for a doctor.

If faith is a belief in the rightness of your cause, or the effectiveness of your method, then it implies the taking of a decision on a hunch—a conviction based on rather slender evidence. If those around you are either lukewarm towards your belief or frankly sceptical, your faith may be shaken. Think carefully before you give it up. You may be the odd man out, but you may also be the only man to have seen the possibilities. It doesn't follow that you are a genius: it may mean simply that your brain is the only one to have been "programmed"—largely fortuitously—in the special way that makes sense of your belief.

It is at this point, when a man fortifies his inner conviction against all advice, that he is in danger of becoming an eccentric in the eyes of his fellows. Then his cause is surely lost. His arguments become unreasonable and his attitude to others one of intolerance. The more people he approaches for support, the more emotional he becomes, and the less likely is he to win adherents. How many brilliant ideas have been lost because the promoters have been their own worst enemies? I have met some of these men—tragicomic figures, embarrassingly difficult to converse with. Sometimes I wish there were time to look into their arguments, to follow the thread carefully through the jungle of their thoughts.

Is there anything we can do to help them? I believe there is. Assuming they are not hot-gospellers for perpetual motion, I think we should bring them to their senses by telling them that somehow they must now devote to a study of human nature the same patience and interest that they have bestowed on their brain-children. If one of them can play this dual role, he is the genius among them.

Letters to the Editor

Rewarding Workers' Efforts

SIR, While recognizing that Mr. Eardley Beswick presents a most interesting approach to payment by results in his recent article "A Better Way to Reward Workers' Efforts" (ENGNG., 28 July '61, p. 102), his general arguments on piecework and rate fixing are biased and do not constitute balanced criticism.

Achievements in work measurement in progressive industries during the last decade have been substantial and progress is being made towards overcoming many of the drawbacks associated with the old rate fixing methods.

Whatever formula is used for determining bonus, the ultimate success of any incentive payment system depends upon satisfactory work measurement. It is true that in simple cases of repetitive production the estimation of an attainable target from past records or by other means may not be difficult.

The real problem, however, lies in the case of production of a variable nature, where work measurement is essential not only for the determination of standard times for incentive purposes, but also for the preparation of accurate advance estimates.

In considering this matter it is important to acknowledge that a large number of the workers in engineering production enjoy straight piecework and would not be inclined to accept a bonus system yielding the low rates of incentive payments described, unless a major revision of base rates in their favour were contemplated.

Under these circumstances, the task facing management is the development of work measurement techniques, in close consultation with workers, to the point where there is confidence on both sides that effort and reward are fairly related. New methods of evaluating bonus payments can have only a limited value under present-day conditions.

Yours faithfully,

P. F. JONES.

Dartford,
Kent.
15 September, 1961.

The Cape "Alligator" Rotary Respirator

SIR, I was very interested to read your Product Profile of the Cape "Alligator" rotary respirator (ENGNG., 8 Sept. '61, p. 322).

As one of the more fortunate victims of poliomyelitis who made a complete recovery, I have good reason to remember the non-rotating "Alligator" during the early part of 1958 when I was a patient in Western Hospital, Fulham.

As I began to recover I naturally took a keen interest in the machine which was saving my life, and well recall the discussions we had about the problems of turning a patient, and Dr. Howlett-Kelleher's determination to have, among the many other mechanical aids in his department, a rotary respirator.

As you state, there are few diseases so demoralizing as poliomyelitis. The victim, reduced to a state of complete helplessness almost within hours, suffers considerable mental anguish as his world shrinks to the confines of the respirator.

For this alone I am pleased to note the greatly improved design and finish of the "Alligator" series as compared with the old respirator. A bright and cheerful environment, even if limited, together with the comfort of a well made device where he can be attended to with the minimum of disturbance, does much to alleviate the patient's fears.

The enthusiasm and devotion of people like Dr. Howlett-Kelleher, and the ingenuity of firms like the Cape Engineering Company deserve every praise and encouragement.

Yours faithfully,

D. E. FIFORD.

Richmond, Surrey.
11 September, 1961.

Simplified Lubrication Formula

SIR, May I make a few comments on the valuable Research Report entitled "New Roller-Bearing Lubrication Formula" by Dr. D. Dowson and Dr. G. R. Higginson (ENGNG., 4 Aug. '61, p. 158)?

In discussing material properties the authors confine their remarks to the influence of the materials parameter G and are content to say that "large variations in film thickness cannot be expected from this source." This seems to be an inadequate comment, for when the more representative quantity E' is examined it can be shown that its ultimate influence on film thickness is only as the power 0·03.

The accompanying table lists the relevant elastic properties of a few metallic materials covering an extreme range of values. The calculated values of $(E')^{0\cdot03}$ are seen to be very nearly constant.

Is it not fair to conclude that, for the purpose of practical applications such as those mentioned in the authors' closing paragraph, material effects may be ignored altogether by assuming a representative value for $(E')^{0\cdot03}$ of $\frac{8}{9}$?

In this case H^* becomes $\frac{8}{9}\,\frac{\gamma^{0\cdot6}\,(\eta_0\,u)^{0\cdot7}}{w^{0\cdot13}\,R^{0\cdot57}}$ being a function of lubricant, speed, load and curvature. Film thicknesses calculated in this way are within 2 per cent of those determined by the authors' equation (2).

One further point is that the power a is given as 0·13 whereas it obviously should have been printed $-0\cdot13$.

Elastic Properties of Some Engineering Materials

Material	Modulus of elasticity (lb/in²)	Poisson's ratio	$(E')^{0\cdot03}$
Steel	30×10^6	0·30	1·680
Aluminium	10×10^6	0·33	1·628
Brass	13×10^6	0·33	1·641
Aluminium bronze	18×10^6	0·35	1·667
Cast iron	12×10^6	0·25	1·633

Your faithfully,

F. J. WREN.

New Duston,
Northampton.
5 September, 1961.

Welding of Tantalum

SIR, I was interested to read an article "Fabrication Problems with Tantalum" (ENGNG., 1 Sept. '61, p. 281) and to learn that the Royal Dutch/Shell Petroleum people are working on the welding of tantalum.

I was surprised to learn from this article that there is only a very limited amount of know-how available on fabrication of this metal and that the Shell engineers had adapted the technique of welding in an inert atmosphere of argon similar to that used for welding titanium.

To the best of my knowledge there is a good deal of know-how available on fabrication of tantalum, both in this country and America, and also in Germany, and certainly those with experience of the working of the refractory metals regard the welding of tantalum as one of the simplest of operations. It may surprise the Shell engineers to learn that it is more probable that the argon welding of titanium was copied from the argon welding of tantalum than vice versa.

Much has been published on the welding of tantalum and anyone requiring information on this subject could probably obtain what they want by referring to my book *Tantalum and*

Letters to the Editor

Niobium, published by Butterworths Scientific Publications in 1959.

Yours faithfully,
G. L. MILLER,
Research Manager.

Murex Limited,
Rainham, Essex.
15 September, 1961.

Marleyglaze Extruded Vinyl Sheeting

SIR, With reference to your editorial notice on Marleyglaze (" Vinyl Sheeting for Roof Lights," ENGNG., 25 Aug. '61, p. 243), which we were very pleased to see and in which it was stated that we claim to be the first manufacturers of extruded corrugated vinyl sheeting in this country; you point out that at least one other firm has been offering a similar product and give BX Plastics as an example.

I would point out that the only similarity between these two products is that they are both made of vinyl. Marleyglaze is an *extruded* product, whereas BX Plastics produce a calendered product. You mention this in your editorial, but is the difference fully appreciated? The difference between extruded and calendered methods of manufacture are very great, and in this case give big economic advantages to the extruded product.

So you won't mind if we repeat that Marleyglaze *is* the first extruded corrugated vinyl sheeting to be made in this country.

Yours sincerely,
D. DANISCHEWSKY,
Press Officer.

The Marley Tile Company Limited,
Sevenoaks, Kent.
11 September, 1961.

Events in Advance

Meetings and Papers

The address and telephone number of the headquarters of each institution are given at the end of this list. Meetings in the headquarters town are held there unless otherwise stated.

British Association for Commercial and Industrial Education

LONDON
" Closing the Gap Between Industry and the Schools ": Discussion. London and Home Counties Group. Mullard House, Torrington Place, WC1. Tues., 3 Oct., 2.30 p.m.

British Institution of Radio Engineers

LONDON
" Methods Used for the Study of Vibration in Aero Engines," by D. A. Drew. Electro-Acoustics Group. London School of Hygiene and Tropical Medicine, Keppel Street, WC1. Wed., 4 Oct., 6 p.m.
CARDIFF
" The SECAM Colour Television System," by G. B. Townsend. South Wales Section. Welsh College of Advanced Technology, Cardiff. Wed., 4 Oct., 6.30 p.m.
CHELTENHAM
" Colour Television," by P. S. Carnt. South Midlands Section. North Gloucestershire Technical College, Cheltenham. Fri., 6 Oct., 7 p.m.
MANCHESTER
" Basic Principles of Digital Computers ": Discussion. North Western Section. Reynolds Hall, College of Technology, Manchester. Thurs., 5 Oct., 7 p.m.

Combustion Engineering Association

CARDIFF
" The Factories Acts in Relation to Boilers and Pressure Vessels ": Discussion, to be opened by H. Entwistle. Western Region. Park Hotel, Cardiff. Tues., 3 Oct., 10 a.m.

Illuminating Engineering Society

LONDON
" The Society's Contribution to Lighting Technology ": Presidential Address, by W. T. Souter. Royal Institution, Albemarle Street, W1. Tues., 10 Oct., 6 p.m.
EDINBURGH
" The New IES Code," by R. Croft. Edinburgh Centre. YMCA, 14 South St. Andrew Street, Edinburgh. Wed., 4 Oct., 6.15 p.m.
GLASGOW
" The New IES Code," by R. Croft. Glasgow Centre. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow C2. Thurs., 5 Oct., 6.30 p.m.
SHEFFIELD
Chairman's Address, by B. Ruston. Sheffield Centre. Grand Hotel, Sheffield. Mon., 9 Oct., 6.30 p.m.

Institute of Marine Engineers

LONDON
Technical Film Show. Mon., 2 Oct., 6.30 p.m.
" The Marine Engineer and the Common Life ": Presidential Address, by C. C. Pounder. Tues., 3 Oct., 5.30 p.m.
" Boiler Water Treatment," by C. J. Haslar. Poplar Technical College, Poplar High Street, E14. Thurs., 5 Oct., 6.30 p.m.
KINGSTON-UPON-HULL
" Marine Diesel Engine Bearings: Materials and Design," by P. T. Holligan and R. W. Joy. Kingston-upon-Hull and Humber Area Section. Royal Station Hotel, Kingston-upon-Hull. Thurs., 5 Oct., 7.30 p.m.
LIVERPOOL
" The Chemical Cleaning of Ships' Machinery," by Dr. H. R. Hamburg and P. F. Dilnot. Merseyside and North Western Section. Liverpool Engineering Society, 9 The Temple, 24 Dale Street, Liverpool. Mon., 2 Oct., 6 p.m.

Institute of Metals

LONDON
" Plutonium," by W. B. H. Lord. London Local Section. Thurs., 5 Oct., 6.30 p.m.
GLASGOW
" Physical Methods of Analysis for Major Alloying Constituents," by K. M. Bills. Scottish Local Section. Institution of Engineers and Shipbuilders, 39 Elmbank Crescent, Glasgow C2. Mon., 9 Oct., 6.30 p.m.
OXFORD
" High-Temperature Alloys," by Dr. W. Betteridge. Oxford Local Section. Cadena Café, Cornmarket Street, Oxford. Tues., 3 Oct., 7.15 p.m.
SWANSEA
" Welding of Non-Ferrous Metals," by J. G. Young. South Wales Local Section. Metallurgy Department, University College, Swansea. Tues., 10 Oct., 6.30 p.m.

Institute of Petroleum

LONDON
" Packaging of Lubricants," by H. G. Priest. Wed., 4 Oct., 5.30 p.m.

Institute of Road Transport Engineers

GLASGOW
" The Roadrailer," by J. A. Simms. Scottish Centre. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow C2. Mon., 2 Oct., 7.30 p.m.
LEICESTER
" Modern Vehicles for the Motorway," by A. H. Carter. East Midlands Centre. Empire Hotel, Leicester. Wed., 4 Oct., 7.30 p.m.
MANCHESTER
" Glass Fibre Reinforced Plastics," by G. O. Gurney. Manchester Centre. Engineers' Club, Albert Square, Manchester. Mon., 2 Oct., 7.30 p.m.
PETERBOROUGH
" Fuel Developments," by L. P. F. Drake. Eastern Centre. Refectory, Peterscourt Office, F. Perkins Ltd., Peterborough. Tues., 3 Oct., 7.30 p.m.

Institution of Civil Engineers

LONDON
" Three Prestressed Concrete Railway Bridges," by Frank Turton. Tues., 3 Oct., 5.30 p.m.

Institution of Engineers-in-Charge

LONDON
" Sources of Technical Information ": Presidential Address, by Dr. Ezer Griffiths. Caxton Hall, off Victoria Street, SW1. Wed., 11 Oct., 6.30 p.m.

Institution of Engineers and Shipbuilders in Scotland

GLASGOW
" In Search of Economic Stability and Security ": Presidential Address, by I. M. Stewart. Tues., 3 Oct., 6.30 p.m.

Institution of Heating and Ventilating Engineers

MANCHESTER
" A New Approach to the Psychrometric Chart," by G. R. Binns. Manchester Branch. Engineers' Club, Albert Square, Manchester. Fri., 6 Oct., 6.30 p.m.
NEWCASTLE UPON TYNE
" Heating and Ventilating in Modern Offices or Hotel Blocks with Emphasis on High-Velocity Single-Pipe Systems," by C. F. Regenberg. North East Coast Branch. Neville Hall, Westgate Street, Newcastle upon Tyne. Tues., 3 Oct., 6.30 p.m.
NOTTINGHAM
" Applications of Solid Fuel to Central Heating Systems, with Special Reference to the Clean Air Act ": Discussion. East Midlands Branch. College of Arts and Crafts, Waverley Street, Nottingham. Wed., 4 Oct., 6.30 p.m.

Institution of Mechanical Engineers

LONDON
" Importance of the Design Stage," by the chairman of the Automobile Division. Annual Report of the Automobile Division. Tues., 10 Oct., 6 p.m.
" Design and Manufacture of Cigarette Making Machinery," by Desmond Molins. Nominated Lecture. Wed., 11 Oct., 6 p.m.
COLCHESTER
" The Bearings of Psychology and Medicine upon Engineering," by Sir Frederic Bartlett. James Clayton Lecture. Eastern Branch. Red Lion Hotel, Colchester. Red Lion Hotel, Colchester. Tues., 10 Oct., 7.30 p.m.

Institution of Production Engineers

LONDON
" Hovercraft," by J. M. George. London Section. Royal Aeronautical Society, 4 Hamilton Place, W1. Thurs., 12 Oct., 7 p.m.
BIRMINGHAM
" Manufacturing Techniques on the Armstrong Whitworth Argosy," by R. A. Courtman. Birmingham Graduate Section. James Watt Memorial Institute, Great Charles Street, Birmingham 3. Tues., 10 Oct., 7 p.m.
BRISTOL
" Rocket Propulsion of Aerodynamics and Space Vehicles," by E. G. D. Andrews. Joint meeting with the local branch of the Royal Aeronautical Society. Western Section. Large Engineering Lecture Theatre, The University, Queen's Walk, Bristol. Wed., 4 Oct., 7 p.m.
MANCHESTER
" Spark Machining and Similar Processes," by K. Appelbee. Manchester Section. Manchester College of Science and Technology, Sackville Street, Manchester. Mon., 9 Oct., 7.15 p.m.

Institution of Structural Engineers

LONDON
Presidential Address, by F. R. Bullen. Thurs., 5 Oct., 6 p.m.
BRISTOL
Chairman's Address, by Clifford E. Saunders. Western Counties Branch. Queen's Building, University Walk, Bristol. Fri., 13 Oct., 6 p.m.
GLASGOW
Chairman's Address, by K. D. Mathewson. Scottish Branch. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow C2. Mon., 9 Oct., 7 p.m.

Junior Institution of Engineers

LONDON
" Sheik's Delight," by Richard W. Shaw. Fri., 6 Oct., 7 p.m.

Leeds Metallurgical Society

LEEDS
" The Strength of Alloys," by Professor R. W. K. Honeycombe. University Staff House, University Road, Leeds. Thurs., 5 Oct., 6.30 p.m.

Newcomen Society

LONDON
" John Rennie (1761-1821)," by Dr. Cyril T. G. Boucher. Annual General Meeting. Wed., 4 Oct., 5.30 p.m.

Radar and Electronics Association

LONDON
" Space Communications." Part 1, " Systems and Equipment," by L. F. Mathews. Royal Society of Arts, John Adam Street, Adelphi, WC2. Thurs., 12 Oct., 6 p.m.

Reinforced Concrete Association

LIVERPOOL
" Hyperbolic Paraboloids," by J. D. Bennett and Charlotte Hume. North Western Branch. Liverpool Engineering Society, 9 The Temple, 24 Dale Street, Liverpool. Tues., 3 Oct., 6.30 p.m.
MANCHESTER
" Hyperbolic Paraboloids," by J. D. Bennett and Charlotte Hume. North Western Branch. College of Technology, Sackville Street, Manchester. Mon., 2 Oct., 6.45 p.m.

Royal Statistical Society

LONDON
" Some Results on Inventory Problems," by A. R. Thatcher. Research Methods Meeting. London School of Hygiene and Tropical Medicine, Keppel Street, WC1. Wed., 4 Oct., 5 p.m.
" Quality Control: The Statistical Content as a Means to an End," by A. F. Cowan. Industrial Applications Section. London School of Hygiene and Tropical Medicine, Keppel Street, WC1. Fri., 6 Oct., 5.15 p.m.

Society of Instrument Technology

LONDON
" Process Control in Paper Mills," by H. B. Whitehouse and M. I. MacLaurin. Control Section. Manson House, 26 Portland Place, W1. Wed., 11 Oct., 7 p.m.
FAWLEY
" Instrumentation in the Paper Industry," by H. Wigman. Fawley Section. Administrative Building, Esso Petroleum Co., Ltd., Fawley. Fri., 6 Oct., 5.45 p.m.
MANCHESTER
" Instrumentation as an Aid to Fuel Efficiency," by R. Clare. Manchester Section. Literary and Philosophical Society, 36 George Street, Manchester 1. Mon., 9 Oct., 6.45 p.m.

West of England Metallurgical Society

BRISTOL
" Creep: The Potential Influence of Theory in Practice," by Dr. D. McLean. College of Science and Technology, Ashley Down, Bristol 7. Wed., 13 Oct., 7 p.m.

British Association for Commercial and Industrial Education. Apply to Mr. T. H. J. Field, British Road Services, Melbury House, Melbury Terrace, London NW1. (PADdington 1161)
British Institution of Radio Engineers, 9 Bedford Square, London WC1. (MUSeum 1901)
Combustion Engineering Association, 70 Jermyn Street, St. James's, London SW1. (WHItehall 5536)
Illuminating Engineering Society, 32 Victoria Street, London SW1. (ABBey 5215)
Institute of Marine Engineers, Memorial Building, 76 Mark Lane, London EC3. (ROYal 8493)
Institute of Metals, 17 Belgrave Square, London SW1. (BELgravia 3291)
Institute of Petroleum, 61 New Cavendish Street, London W1. (LANgham 3583)
Institute of Road Transport Engineers, 1 Cromwell Place, South Kensington, London SW7. (KENsington 3744)
Institution of Civil Engineers, Great George Street, London SW1. (WHItehall 4577)
Institution of Engineers-in-Charge, 13 Grange Close, Edgware, Middlesex. (MILl Hill 3543)
Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow C2. (Central 5181)
Institution of Heating and Ventilating Engineers, 49 Cadogan Square, London SW1. (SLOane 3158)
Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, London SW1. (WHItehall 7476)
Institution of Production Engineers, 10 Chesterfield Street, London W1. (GROsvenor 5254)
Institution of Structural Engineers, 11 Upper Belgrave Street, London SW1. (SLOane 7128)
Junior Institution of Engineers, Pepys House, 14 Rochester Row, London SW1. (VICtoria 0786)
Leeds Metallurgical Society. Apply to Dr. P. R. Beeley, The University, Leeds.
Newcomen Society, Science Museum, Exhibition Road, London SW7. (KENsington 1793)
Radar and Electronics Association, 43 Grove Park Road, London W4.
Reinforced Concrete Association, 94-98 Petty France, London SW1. (ABBey 4504)
Royal Statistical Society, 21 Bentinck Street, London W1. (WELbeck 7638)
Society of Instrument Technology, 20 Queen Anne Street, London W1. (LANgham 4251)
West of England Metallurgical Society. Apply to Mr. P. C. Thornton, College of Technology, Bristol.

Designing Bodies for Maximum Comfort

Car passenger compartments can be designed around silhouettes of people. But selecting a representative silhouette is difficult. New data on limb dimensions are available, and could form the basis of a standard procedure.

THE idea that a car is a horseless carriage has died hard. Indeed there are still cars on the roads today that owe more to the stage-coach designer than to the automobile engineer. But the situation is changing. The demand for higher speeds and economy are seeing to that. Superfluous weight and space make speed expensive.

Modern cars are designed around the driver and passengers. Their needs—good vision, comfort, safety—determine the shape of the passenger compartment. This, in turn, influences the shape of the complete car.

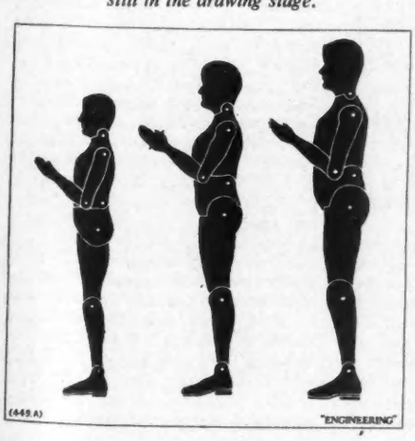
But cars are mass-produced, not made to measure. So the designer has to find a passenger compartment, seat design, and control arrangement that suits the greatest number of people. And there the problems start. As any tailor will tell you, people come in all shapes and sizes and in cars there is the additional difficulty that different sizes of people take up different positions in the passenger compartment. For example, heavier people sink further into their seats, and so alter the head and leg room available to them, change their eye level, and have to reach a different distance to the controls.

TABLE OF PART SIZES

A comprehensive table of the variation in dimensions of individual parts of American male bodies is set out in a paper "A 2-D Mannikin—The Inside Story," by S. P. Geoffrey of the Ford Motor Company, Dearborn, Michigan. The paper was read at the 1961 SAE International Congress and Exposition of Automotive Engineering, Cobo Hall, Detroit.

The paper tells how data were collected with a view to assisting design of an optimum human side-view template. This in turn is intended as an aid to designing space and seating requirements in a car. The result is a seated male two-dimensional side-view template, referred to as "Oscar." It is labelled with 44 dimensions, each of which has, in general, 19 values assigned to it in a percentile distribution chart (that is, the values are given in 5 percentile steps). Thus, as far as stature is concerned, the chart indicates that a 95th percentile male has a height of 73·01 in; so 95 per cent of the male population have a height less than this. A 50th percentile male has a height of 68·5 in, and this is the average height for the population studied.

Flat dummies, called "Oscars," can be used to check the accommodation of a car while it is still in the drawing stage.



For the basic figures of stature and weight, all sources showed general agreement; so the latest and largest sampling of data was used—that for 190,502 male Texas drivers.

While there were figures available for most bone lengths and bone-pivot distances, no information was to hand for the effective bone-link dimension between hip and shoulder joints. For this measurement, an X-ray was taken of a number of subjects in the four highest stature percentiles. This not only gave the dimension required but also gave information on bone and flesh-line relationships in seated-erect and normal driving postures.

However, although the paper provides a comprehensive series of percentile dimensions, it is left to the designer to choose how to use them. One of his difficulties is the relation between the percentiles. How is he to know the proportion of the driving population that has, for instance, long arms and short legs?

In a paper "How Can the Physiologist Contribute to the Improvement of Automobile Seats," by F. Picard and A. Wisner, of Regie National des Usines Renault, Billancourt, the results of correlation studies of the limb lengths of 216 truck drivers are described. This paper was read at the conference previously mentioned. The survey, which was of a more uniform group than the general run of car drivers, showed that correlation between thigh and forearm lengths, for example, is not always high. A forearm length of 14½ in could be recorded on a driver having a thigh measuring 22 in or 26 in. This shows that mere adjustment of the seat in a forwards or backwards direction is not sufficient to ensure comfort for everyone, and the addition of an adjustable seat back is necessary for a certain number of drivers. It would presumably be possible to measure drivers when they purchase a car and provide the correctly shaped seat.

But adjustment of the seat in this way is not the complete answer. For instance, if there is an excessive distance between the lower rim of the steering wheel and the depressed brake pedal (over 29½ in), no seat adjustment is going to enable the driver having short legs to apply the correct pressure to the brake pedal. Many examples can be quoted where poor design of the driving position has led to a bad sitting position for which the seat itself cannot be held responsible.

DESIGN PROCEDURES

The way General Motors design a passenger compartment is described in a paper "The General Motors Comfort Dimensioning System," by V. D. Kaptur, jnr., and M. C. Myal.

The leg reach of a 90th percentile adult is used as a standard for compartment design and is quoted as 43·8 in. The way in which this measurement is reached is not defined, but the comparative measurement on the two-dimensional Oscar of the previous paper appears to be 39·95 in. The difference is probably accounted for by different reference points of measurement; but it illustrates the need for standardization in this field. The other basis for compartment design used by General Motors is the body weight of a 50th percentile male, 167 lb (this is equivalent to a 92·5 percentile female).

Normally the compartment designer has information regarding the location of the chassis and engine components, the wheelbase, and the fore and aft location of the engine and front wheels, which determine the position of the bulkhead of the proposed car. The underbody is then designed to clear the chassis structure.

Four comfort angles are used to draw up the size of the compartment—foot angle, 75° to 130°; knee angle, 80° to 170°; hip angle 60° to 110°; back angle, 20° to 30°. These are set up on two-dimensional mannikins that slide over the full-scale drawing of the car. The seats and compartment limits are then drawn around them.

Prototype seating arrangements can be assessed with a three-dimensional tool that indicates limb angles and head clearance.

From the drawings, a full-scale three-dimensional model of the compartment is produced and the passenger space dimensions are checked with a three-dimensional tool, shown in the illustration. The tool is designed to represent the body contours, where these touch the seat, of a man of 90th percentile height and 50th percentile weight. It is equipped with a measuring arm representing a 90th percentile leg, terminating with a shoe contour of a 90th percentile foot. A graduated sliding probe measures the distance from the hip joint to the head lining of the compartment.

The procedure at the Renault works is somewhat different. The low correlation found in body dimensions prompted the company to construct a number of dummies with "non-average" shapes: long legs, medium bodies, and medium arms; short legs, medium bodies, and medium arms; and so on. A number of these "atypical" Oscars are shown in the illustration. These help to show what happens when different people sit in a proposed car, when it only exists in a drawing.

For testing driving positions the company have a simple framework in which various seat and control positions can be set up quickly and easily. Any experimental arrangement can be tried out by an average man, or by a man harmoniously large, or harmoniously small, or by men with short bodies and long legs, etc. It is easy to find these live Oscars among members of the design department. Photographs can be taken and the body angles measured to see whether the position produced is suitable.

In this respect the body angles specified at Renault are—foot angle, 85° to 95°; knee angle, 100° to 120°; hip angle, 85° to 100°; back angle, 10° to 20°. Comparison with the General Motors angles suggests that ideas of comfort vary between Europe and the United States, and again shows the need for standardization. After all, the result of going outside the specified angular limits is said to be the inevitable appearance of cramp after a certain time, in such parts of the body as the calf, the loins, and the nape of the neck.

More and more work is being carried out on the components of comfort—sitting attitude, ride qualities of the suspension, ambient noise, temperature, tolerance of vibration, etc.—but the specification of an overall "comfort index" is still a long way off. At present it is just a question of paying your money and taking what is given to you.

Human Element

Building Firm Introduces Safety Cup

BY GIVING a "Safety Cup" for competition among their building sites, Holland & Hannen and Cubitts (Great Britain) Limited, the civil engineering contractors, have effectively cut down their accident rates. Presenting the new cup for the first time, the company's managing director, Mr. J. M. Harris, said that accident frequency had dropped from 2·24 in the first six months of 1960 to 1·7 in the second six months, and again, to 1·67 in the first half of 1961.

"This result is most encouraging," said Mr. Harris. "Our industry, let's face it, is accident prone. We have no permanent factories to work in. Our job is outdoors and we shall always work from improvized quarters, exposed to the hazards of British weather. Safety at building sites is therefore the concern of every single working man there and it is up to the supervisors and managers to make their men safety conscious."

An important point about Cubitt's Safety Cup is its recognition of efforts to prevent accidents as well as making comparisons between figures actually attained. This makes it possible for the larger sites to compete on equal terms with the smaller sites which, with smaller numbers of workmen, find it easier to avoid accidents and so show up well in an analysis of percentage figures. The cup goes to the site which not only has a good safety record, but also pays the strictest attention to compliance with the Building Regulations.

In his report on the contest, Mr. A. R. Brown, a former District Factory Inspector for Liverpool, who acted as independent assessor, said, "The most valuable material on any site is the man engaged on the work. Great care is taken to ensure that expensive panel work or special architectural features are preserved from the slightest chip or scratch. Provided that they exercise care for themselves, the men employed are entitled to the same consideration, and it is gratifying to see that Cubitts are doing so much in a progressive endeavour towards that end."

If the introduction of a safety competition and cup can play such an important part in an industry so accident prone as building, then it might be a useful tip for manufacturing industries.

Indian College of Engineering and Technology

Courses of study at the new College of Engineering and Technology in New Delhi were formally inaugurated last month by Professor Humayan Kabir, India's Minister of Scientific Research and Cultural Affairs. The College has been opened in collaboration with the British Government—who have provided five teachers and two workshop supervisors—and the Federation of British Industries—who have given foreign exchange for the equipment and machinery. In his speech, Professor Kabir referred to British/Indian co-operation in various fields as one of the strongest factors in international understanding in the world today.

Degree courses will be offered by the College in civil, mechanical, electrical and chemical engineering and in textile technology. Graduates from these courses will have have a ready opportunity to contribute to their country's rapid industrialization for, by the end of the current Third Five-Year Plan, India aims to be in a position to produce industrial and electrical machinery worth more than £468·75 million a year compared with £120 million at the beginning of the Plan.

Last year the major items of plant and equipment production were cables and wires, railway locomotives and equipment, fabricated structures, locomotives, cotton textile machinery, machine tools, electric motors, diesel engines, transformers, and sugar mill plant.

Top Managers Learn the Export Ropes

An Export Training Centre for top management, claimed to be the first of its kind in this country, has been opened in conjunction with the Management Centre at Sundridge Park, Kent. It will help the national export drive by providing comprehensive training facilities on three-week residential courses. These courses, which began this month, have been planned in consultation with a special advisory panel set up by the Federation of British Industries, and are intended for managing directors, export sales directors and all senior sales executives concerned with the promotion of export business.

All the main factors affecting export policy and marketing procedures in present world conditions will be studied, and the principles and techniques discussed will apply equally to large and small organizations, irrespective of the type of product manufactured. Subjects covered include the selection of markets, conducting of market surveys, appointment of selling agents, methods of determining prices, control of overseas sales forces and the most appropriate kind of advertising. Special attention is paid to Common Market trading and to selling to communist countries.

Lectures are given by members of the Sundridge Park staff and also by visiting speakers from industry, commerce, government departments and other official bodies. The interchange of experience forms an important part of the courses and special periods have been allotted for both formal and informal discussions.

Sundridge Park Management Centre was set up in 1955 as a non-profit making educational trust by Personnel Administration Limited, the management consultants. Last year, in response to the government's appeal for more exports, it initiated a series of one-week residential courses on the subject of export management. From these was born the idea of a separate Export Centre devoted to the study of exporting and the training of those responsible for the export activities of their firms.

Clearly, a training centre of this kind devoted to studying and training in export techniques can have an important part to play in breaking down our lingering insularity in trading. At the risk of being carping, however, it seems rather a pity that industry has not created such a training centre during the fifteen or so years since the war when exports have been a national need, instead of waiting until the Common Market makes it essential for the good of individual firms.

Wages Council Shuttlecock

Earlier this month, the Industrial and Staff Canteen Undertakings Wages Council considered the Minister of Labour's first shot in the developing battle of the "wage pause"—the rebuff of their June proposals.

The Council have now resubmitted their proposals to the Minister unchanged, with another request that a Wages Regulation Order giving effect to them be made. There are three grounds on which the Wages Council consider that the Minister's rejection of their proposals is ill-advised.

The first is that the settlement reached by agreement on 9 June, and arising from a claim notified to the Council on 27 March, is regarded by both employers and workers' representatives as a commitment entered into in view of the "normal expectation" that the Minister would in due course give effect to it. In considering the Chancellor of the Exchequer's "little budget" statement, the Council noted the indication that "where commitments have already been entered into they should be met."

On this objection to the Minister's action, the Council are right in saying that the "normal expectation" is that their recommendation would be simply rubber stamped and, therefore, it was assumed by both sides of the industry to be a *fait accompli* before the Chancellor's announcement. However, by a strict interpretation of the procedural rules, the Minister is right in holding that he is, in fact, the final arbiter and no agreement is complete until approved by him and that, therefore, the recommendation had not been approved by the time that the Chancellor spoke the fatal words.

The Council's second objection is that they are concerned with minimum levels of pay only, to provide statutory protection for the workers involved and in these circumstances, it is difficult to see that their proposals can be inflationary.

Objection number three is one which has been heard, and will be heard, from many other wage negotiating bodies for as long as the wage pause is enforced. This is that, to be effective and efficient, the Council needs a high degree of confidence and goodwill between the two sides of the industry and, equally important, between each side and those whom it represents. This is a particularly crucial state of affairs in the case of this Wages Council, which had thought its proposals virtually accepted, but this loss of confidence between negotiators and between them and the people for whom they act can have a debilitating effect on industry.

When two negotiating bodies which have gained the respect of each other and of their followers are suddenly emasculated by an arbitrary third force, both sides lose leadership and there can be a loss in industrial morale and, therefore, production. This might not be a serious threat in this particular case—the catering industry—but it could become serious in other industries.

Cotton Board Travel Scholarships

The Cotton Board have announced the introduction of a completely new scheme of travel scholarships for textile designers. There are already scholarships for students of textile design, but this is the first scheme to provide substantial awards for established designers already working in the cotton industry.

Up to £2,000 is available in any one year, but the value of each award will vary with circumstances and will take into consideration the needs of the industry and the special talents and interests of the designer. A successful candidate might, for example, find stimulation for his creative ability by visiting centres of artistic and cultural activity in Europe or America. He might even visit Australia, South Africa or other markets where the British cotton industry has substantial interests.

The final date for receipt of applications for this year's awards is 31 October, and it is intended that the successful candidates will undertake their projects next spring. The reports which the designers bring back will be used by the Cotton Board in whatever way is considered to be in the best interests of the industry as a whole.

The Cotton Board already offer a number of university and postgraduate scholarships in textile technology and textile chemistry, and it is hoped that the new scholarships will complement these by promoting the highests standards in textile design. Information about the scholarships is available from the Education Officer, The Cotton Board, Royal Exchange, Manchester 2.

Mass Irrigation of Gardens

An irrigation scheme costing £3 million has been proposed to provide water for the gardens of 366,000 small farmer families living in the native reserves in Southern Rhodesia.

This suggestion was put forward by Dr. J. W. Rowland of the Henderson Research Station, Southern Rhodesia, at a ten-day Africa and Irrigation conference recently held in Salisbury and attended by 180 delegates from ten countries. Dr. Rowland felt that this "back garden irrigation" would perhaps do more to improve the conditions of life for more than a million people than any other single measure.

The conference was sponsored by Wright Rain Limited, of Ringwood, Hampshire, with its associate company in Southern Rhodesia, Wright Rain Africa (Pvt.) Limited. On his return from Africa Mr. C. S. Wright, the managing director, said Dr. Rowland's scheme had aroused great interest, and as a result the company had been asked to install one or two pilot schemes.

Dr. Rowland proposed steps to establish "home subsistence irrigated gardens throughout the nature areas, by using pumps and electric, petrol and diesel motors to bring the water in pipes from the depths of the river bed and from boreholes and wells." Each garden would be provided with a sprinkler, and a family would be able to grow green vegetables, potatoes, lucerne and even a little wheat; and to maintain fruit trees as well too. The scheme could represent a powerful counter attraction to urban employment, and relieve unemployment.

COLOUR TELEVISION SYSTEM

Closed-circuit Use

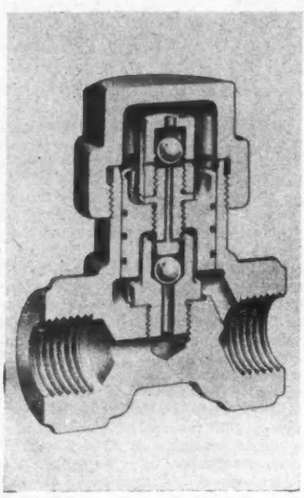
THE Eidophor projector, illustrated, in conjunction with standard television cameras provides a large-screen colour television system for closed-circuit demonstrations. The equipment may be either hired or purchased.

With this system a contrast of 100 to 1, equal to that of a good film projector, is said to be achieved both for detail and for the picture as a whole. The projector produces a large cinema-screen size colour picture up to 12 ft by 16 ft, or up to 24 ft by 32 ft in black and white, on a metallized screen. Colour reproduction, with a high degree of accuracy, is obtained by using a field-sequential system. Synchronized rotating colour wheels are employed both in front of the projector and the camera.

Electrical impulses from the camera control an electron beam. This bombards, and consequently modifies, the surface of a film of oil on a concave mirror. Light, from a 2,000W xenon lamp, passes through the resulting wrinkles in the film and is reflected from the mirror and projected through the slits of a bar system on to the screen. *C.I.B.A. Group of Companies in Great Britain, 96 Piccadilly, London W1.*

STEAM TRAP

One Main Moving Part



STYLED the DYNA trap, this new type of thermodynamic trap has been added to the maker's range of steam traps.

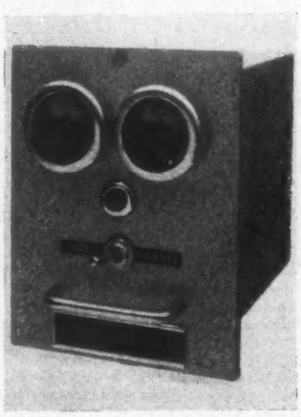
The piston is the only main moving part. The valve consists of a stainless-steel ball, working on a stainless-steel seat. Both valve and seat are replaceable without removing the trap from the line. The trap operates by detecting the alteration in pressure which occurs in a passage when the flow of water changes to steam. This difference in pressure moves the piston thus closing the valve. The piston is actuated by the steam which condenses after a short period, allowing the valve to reopen and discharge any condensate. Should steam alone be present the trap quickly recloses.

It is claimed for the design that it is an unusually flexible one, the characteristics of which can be modified without difficulty. Little or no maintenance is said to be required, but if the valve and seating require replacement this is simple.

This unit will be introduced at the forthcoming Heating, Ventilating and Air Conditioning Exhibition. *Lancaster and Tonge Limited, Withington Street, Manchester 6.*

ANNUNCIATOR UNITS

Instant Indication



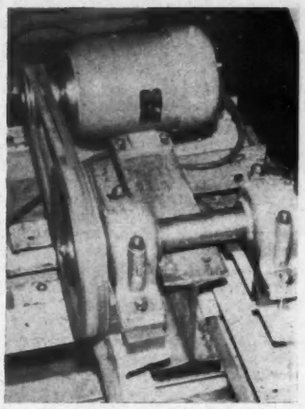
TYPE TAN annunciator units are reported to give instant and clear indication if a fault, or condition requiring action, develops in processing.

These units, working in conjunction with measuring instruments such as contact thermometers, contact gauges, and pressure switches, give both visual and audible indications. The system comprises a master unit and any desired number of signalling units interconnected by plugs and sockets. This enables the original installation to remain flexible. The master unit, suitable for wall or panel mounting, contains a motor-driven flasher, power pack, and provision for controlling an external klaxon or bell together with an indicator lamp. The signalling unit, illustrated, has a red lamp, a green lamp, an "acknowledge" push button, and a "test/normal" switch. Two types of signal units are available, one for use with a normally-open control contact, and the other for a normally-closed control contact.

The system is normally supplied for connection to a 200/250 V ac mains supply but provision can be made for other supplies. The voltage controlled by the external-control contacts is reduced to 50 V dc, and the current switched is approximately 20 mA per way. *Londex Limited, 207 Anerley Road, London SE20.*

GEARED MOTOR

Single-Stage Epicyclic Reduction Train



DESIGNATED the Gamax Mark II, this is an improved version of the Gamax geared-motor unit.

There is a compact single-stage epicyclic reduction train built into the end shield of the fan-cooled totally enclosed electric motor. Output speeds are from 141 to 820 rpm and output torques from 49 to 212 lb in. The unit can be foot or flange mounted, in vertical, inclined, or horizontal positions. Self-adjusting planet pinions ensure balanced load distribution.

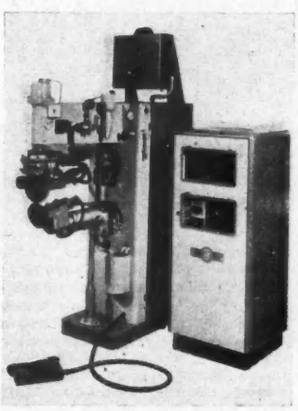
Two types of output shaft are available. One is a flanged hub forming one half of a coupling, which can be coupled direct to the driven member or alternatively, the unit can be supplied complete with a solid or flexible coupling. The other type of shaft is a plain extension and incorporates a Star tolerance ring, which displaces keys, pegs, or grub-screws.

The use of non-metallic gear material for pinions and bearings eliminates the necessity of oil lubrication, a particular advantage in industries where the presence of oil is undesirable. The units are reported to be quiet in operation and free from vibration.

The motors comply with BS 170 (1939) and are suitable for a 400/440V 3 phase 50 c/s supply. *George Angus and Company Limited, Westgate Road, Newcastle upon Tyne.*

SEAM WELDER

Takes Spot-Welding Attachments



THE Speedseam 50 welder is an air-operated seam welding machine. Suitable for circumferential and longitudinal seams of light-gauge mild-steel and coated-steel assemblies, the machine will take spot-welding attachments. The electronic control panel, illustrated, is the Model DEK R/S, which gives optional selection for seam or spot welding. The top seam-welding bearing assembly can be rapidly detached and the appropriate spot-welding horseshoe and electrode shank holder replaced, it is stated, in a matter of minutes. The lower bearing assembly, whether circumferential or longitudinal, can also be replaced by a normal round copper spot-welding arm mounting standard electrode shanks. In this form mild steels up to 0·160 in + 0·160 in and light alloys of the non-heat-treatable type up to 0·048 in + 0·048 in can be welded. Timing control gives cool and weld times of 1 to 90 cycles. Vernier heat adjustment is by an electronic phase shift control.

Speeds from 3 ft to 18 ft per minute can be selected by dc motor control. The throat depth is 20 in and the machine will weld tubes down to 5 in diameter. The nominal rating is 50kVA. A 90 per cent duty cycle is said to be within the operating capabilities. *Sciaky Electric Welding Machines Limited, Falmouth Road, Slough, Buckinghamshire.*

GENERAL-PURPOSE ELECTRODE

Contact or Free Arc

AN improved Diadem Emerald electrode has been produced for general purpose use either as a contact or free arc electrode. It is intended for welding on all thicknesses of mild steel from 14swg upwards. The lighter gauges of this electrode may be used in all positions.

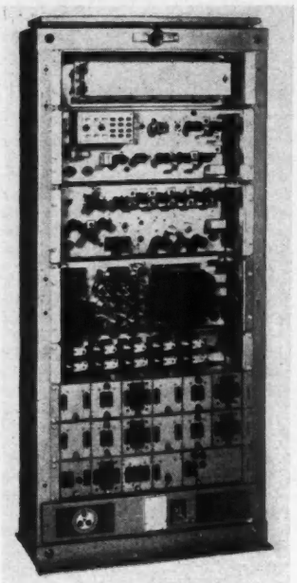
Characteristics of the electrode are reported to be the production of fillet welds of mitre profile, a self-releasing slag, a wide current range, a stable soft arc, and a high burn-off rate at normal currents. The electrode is approved by the Ministry of Transport and Lloyd's Register for down-hand welding on structures of primary importance, and by the Admiralty and Ministry of Aviation E.I.D. for welding mild steel in the flat position. It complies with the requirements of B.S. specifications 639, 1856, 2642, and 968. The electrode is coded E947 on the B.S. 1719–1951 coding and E6012 on the A.W.S.–A.S.T.M. designation.

Deposited metal gives a yield point of 24/28 tons sq. in and an ultimate tensile strength of 29/34 tons sq. in. Elongation on 1·5 in gauge length is 26/32 per cent and reduction of area on 0·424 in diameter 40/50 per cent. The charpy impact value is 40/60 ft lb. Chemical analysis of the weld metal is carbon 0·08–0·10 per cent, silicon 0·11–0·14 per cent, manganese 0·55–0·65 per cent, sulphur 0·025–0·035 per cent, and phosphorous 0·015–0·025 per cent. *Cooper and Turner Limited, Vulcan Road, Sheffield 9.*

XUM

RADIO LINK EQUIPMENT

VHF/UHF 5-channel



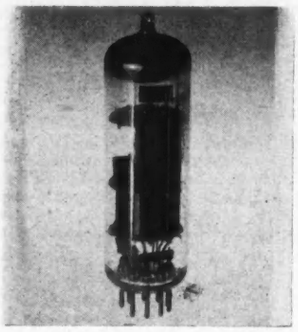
THIS Type HM5 unit, illustrated with the front covers removed, is designed for low-capacity communication systems. It incorporates its own carrier equipment for four telephone channels and one voice frequency channel.

Fully transistorized equipment is incorporated. Each telephone channel can carry up to 24 VF telegraph channels. Operation is in the frequency bands 54-88, 156-184, or 450-500 Mc/s.

The basic equipment consists of a transmitter and receiver, together with the associated power supply and the carrier telephone system. The transmitter is phase-modulated, crystal controlled, and provides a power output of not less than 15W to the coaxial line feeder. The receiver comprises an RF amplifier, mixer, three stages of IF amplification, limiter, and discriminator followed by a baseband amplifier. The receiver unit also incorporates the modulator amplifier for the transmitter. *Marconi's Wireless Telegraph Company Limited, Chelmsford, Essex.*

TRIODE-PENTODE VALVE

Audio-frequency Use



RECENTLY introduced, the ECL86 triode-pentode is an addition to the maker's series of audio valves.

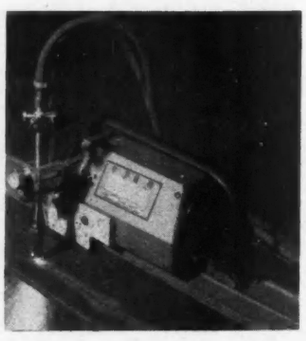
Unlike its predecessor the ECL82, this new valve has been developed for audio-frequency applications exclusively. It is said to offer higher sensitivity consistent with high output, making practicable the use of a greater degree of negative feedback. A signal voltage of 50mV at the triode grid will produce 3W of audio output at the pentode anode in a typical single-valve amplifier.

The triode section of the ECL86 has an amplification factor of 100, and a mutual conductance of 1·6 mA/V. The anode dissipation of the pentode section is 9W, and its mutual conductance 10 mA/V (Ia = 36 mA). In the design of the valve, care has been taken to keep the hum and microphony to a minimum. Maximum hum level referred to the triode grid is 4 microvolts. No special precautions against microphony are said to be required in connection with equipment where the input voltage is not less than 5 mV for an output of 50 mW.

It is claimed that the valve is particularly suitable for use in stereophonic amplifiers. A medium sensitivity stereo gramophone pick-up gives an output of 70 mV, which is reported to be substantially more than the valve requires to give full output. Using two of these valves the makers have designed a stereo amplifier that gives a power output of 3 W per channel. *Mullard Limited, Torrington Place, London WC1.*

CUTTING MACHINE

Uses Acetylene or Propane



KNOWN as the Pug, a portable lightweight oxygen cutting machine is now being marketed.

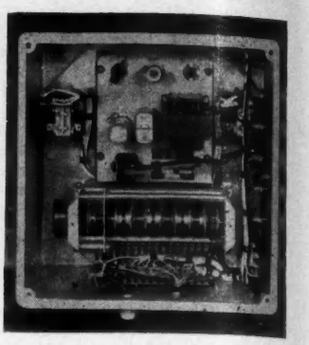
Weighing only 21 lb it is said to be capable of cutting and bevelling steel up to 2 in thick. Running on light alloy track the machine can make a straight cut of any length. Circles from 3 in to 45 in in diameter may be cut with the aid of an adjustable trammel attachment. The cutter can be moved through angles up to 45° for bevelling and can be adjusted vertically and laterally.

Power is supplied by a universal reversible electric motor, suitable for voltages of 220/240 or 110, with a maximum consumption of 80W. The speed range of the cutter is from 7·3 in to 36 in per minute. Speed control is by a rotary-type resistance. The nozzle-mixing blowpipe uses acetylene or propane as fuel gas. The wrap-round handle affords protection in addition to ease of carrying. The cutter, of the MC3 Type, is provided with separate tubes for heating oxygen, fuel gas, and cutting oxygen. Hose connections are $\frac{1}{16}$ in bore BSP. The cutter holder is a zinc-based die casting, spring loaded. There is rack and pinion adjustment for both horizontal and vertical setting. The maximum vertical adjustment is $2\frac{1}{2}$ in and the maximum horizontal adjustment $3\frac{1}{2}$ in.

The aluminium track, which has a gauge of 4 in, can be supplied in lengths of 6 ft, 9 ft, and 12 ft. *The British Oxygen Company Limited, Bridgewater House, St. James's, London SW1.*

SUCROSE DETECTOR

Great Sensitivity



WITH this detector the presence of dissolved sugar can be detected in water, even when the amount of sugar is as low as 2 ppm.

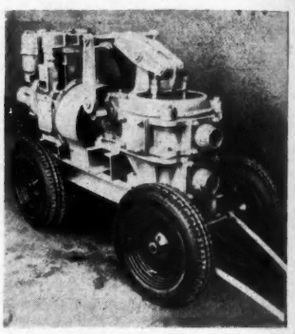
It is claimed that the detector is far more sensitive than those formerly used and that sugar in condensate—previously a source of boiler corrosion—can easily be detected without recourse to laboratory analysis. In outline the method of operation is to boil the sample at low pH in order to hydrolyse sucrose to glucose and fructose. The pH is then adjusted to 11 or above and the reagent (triphenoltetrazolium chloride) added. In the presence of reducing sugars this forms a strongly-coloured precipitate.

The instrument consists of a multi-cam timing device, which operates a number of valves and the electric heater in the proper sequence, and switches in a photo-electric cell. The electrical control equipment is shown in the illustration. The reactions, as well as the measurement, are carried out in a glass tube. A measured sample of water is introduced into the reaction tube and a measured amount of acid is added. An electrical heater brings the acidified sample to the boil for long enough to complete the hydrolysis. A measured quantity of caustic soda solution is next added to correct the pH and this is followed by a measured amount of TTC.

If measurements fall short of a pre-set value an alarm is operated. *William Boby and Company Limited, 23 High Street, Rickmansworth, Hertfordshire.*

DOUBLE-DIAPHRAGM PUMP

Handles Slurries



EMPLOYING two diaphragms to give equally-distributed loading, the new Alcon 3 in/4 in pump is of the lift-and-force type.

Designed to meet the needs of civil, municipal, and highway engineers, and contractors and builders, the unit is a heavy one, capable, it is reported, of handling liquids containing slurries and able to accommodate a high percentage of heavy solids. Power is derived from a Lister LD1 air-cooled diesel engine, as shown in the example illustrated, which develops 2 hp at 1,000 rpm. Alternatively an electric motor can be supplied. Drive is through a flexible coupling to a gearbox and thence by cast-steel rocker arms.

The diaphragms are of reinforced die-moulded rubber. A relief valve on the pump operates in the event of blockage or severe kinking of the delivery pipe. This ensures that the top diaphragm is always lubricated, a feature of value when the pump is unattended. The pump, which is a quick-priming one, has a capacity of 5,000 gallons per hour. The maximum head is 40 ft and the greatest lift 25 ft.

The unit is substantially mounted on a fabricated steel bedplate. The illustration shows tyred wheels, running on roller bearings; 16 in cast iron wheels are also available. The weight is $8\frac{1}{2}$ cwt. The overall length is 7 ft 8 in., the height 3 ft $5\frac{1}{2}$ in, and the width 2 ft $10\frac{1}{2}$ in. *Arthur Lyon and Company (Engineers) Limited, Park Works, Stamford, Lincolnshire.*

MOISTURE METER

Employs Capacitance Method

SIMPLIFIED operation is claimed for the Varsity moisture meter.

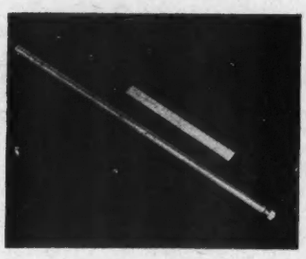
Samples up to 2,000 cc can be tested, the amount of moisture being immediately indicated on the dial. The instrument, which has a single control knob, uses the capacitance method. Operation is at the high frequency of 100 Mc/s, which is claimed to ensure accuracy. The meter measures the capacitance of the container, which is changed when a sample is placed in it. Each substance has its own factor by which the container's capacitance is increased; this dielectric constant (ϵ) is usually 4 or 5 for dry organic substances, for water it is 80.

The change of capacitance increases in a linear manner with increasing weight of test material, but it does not follow that the ϵ increase with the moisture content is linear, although this is usually the case. This instrument is said to be the only commercially-available vhf dial-indicating stabilized moisture meter with an adjustable range. Any number of meters can be standardized to read alike and the ten-turn indicator is reported to be readable to better than one part in a thousand.

Constructed from sheet steel, the meter is intended for continuous factory use. A constant-voltage mains transformer is fitted and the instrument is fully stabilized for 190/260V 50 c/s. The range of Varsity moisture meters available extends to 50 different types. *Shaw Moisture Meters, Rawson Road, Westgate, Bradford, Yorkshire.*

PROPORTIONAL COUNTERS

Boron Lined



DEVELOPED for use at low power levels in the installed neutron flux measuring channels of nuclear reactors, a series of proportional counters has been introduced.

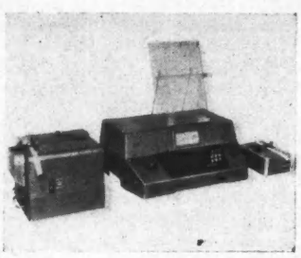
Known as PNI 1077, these counters are constructed of very high purity aluminium which, together with the use of an enriched boron lining and inert gas filling, is reported to permit immediate operation after long periods in high neutron fluxes. Ceramic-to-metal seals and ceramic insulators provide a robust counter claimed to be suitable for plant use. The counter operates at relatively low voltages and a gas multiplication of 50 is obtained at about 750 V. Higher gas multiplication may be used if required.

Irradiation of the counter in a high neutron flux activates the counter body. This produces a background count similar to that obtained in high gamma fluxes, which may be rejected by operating the counter at an EHT value below that at which the pile up of residual activity and gamma pulses is sufficient to pass the discriminator threshold chosen. In practice after long irradiation in a thermal flux of 10^{10} nv this background can be rejected within 10 minutes of the neutron flux. In most cases where the counter is used for the low level neutron flux instrumentation of a reactor no retraction mechanism is said to be necessary to remove the counter once full power is reached.

The counter is claimed to be very resistant to long-term radiation damage and to maintain unchanged its counting characteristics over a total dose of more than 10^{18} nvt. *Plessey Nucleonics Limited, Weedon Road, Northampton.*

TAPE VERIFIER

Indicates Operator Errors



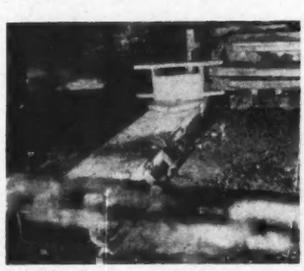
INTENDED specifically for data processing applications, this new version of the Model 90 tape verifier provides means for automatically detecting and eliminating operator errors in the punching of 5-, 6-, or 7-track tapes at speeds up to 15 characters per second.

Operator errors due to incorrect keying, either in original tape preparation or subsequent verification, are automatically and positively indicated, including the presence of unwanted data or the absence of data from the tape. The verifier consists of four separate interconnected units of punched-tape equipment: a Model S4136 multi-wire keyboard, a Model 92 tape reader, a Model 25 tape punch, and a power pack. It is able to function as a normal keyboard perforator for originating 5-, 6-, or 7-track tapes, depending upon the model used, either singly or two at a time.

Operation is based on the automatic comparison of two separate transcriptions of the same source data. The unverified tape is fed into the tape reader and the data typed out a second time from the source document. The units are electronically interconnected in such a way that when the code produced by the second typing agrees with that already punched in the original tape, the same character is punched in a second tape. When the two codes do not agree, the keyboard locks and nothing is punched on the second tape. After determining where the error lies the operator takes appropriate action so that the correct character is punched in the second or verified tape. The power consumption is approximately 100 W. *Creed and Company, Telegraph House, Croydon, Surrey.*

MINE CAR LOADER

Reduces Coal Degradation



A MINE car loader which reduces the amount of degradation of coal at loading points, has been devised by the Chief Engineer of the National Coal Board's Durham Division.

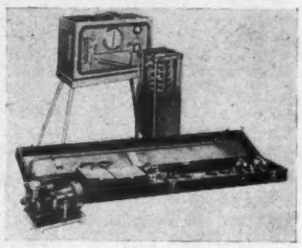
The equipment enables the correct amount of coal to be loaded, eliminates spillage, and facilitates automation. As long as cars are available for filling the main conveyor may be operated continously. Coal from the main conveyor belt is fed into a small receiving hopper on a scraper conveyor designed to deal with peaks and to feed the coal into a special hopper. The bottom strand of the scraper conveyor is used for the level filling of the hopper. This consists of an inner and outer hopper, the whole being supported on load cells. The outer hopper is carried by two hydraulic jacks; when a predetermined amount of coal has entered the hopper they lower the outside container and the coal therein into the mine car positioned below. The scraper conveyor is stopped while loading is in progress. When the level of the downward stroke is reached, the doors of the outer hopper are automatically opened and the hopper withdrawn. The hopper doors are closed when it assumes a raised position, the scraper conveyor motor is restarted, and the cycle repeated. A feeder moves the cars forward and positions them for loading.

The cycle of loading a three-ton car is reported to occupy 10 to 12 seconds. Enclosure of the top of the hopper and the scraper conveyor considerably reduces the amount of dust.

The loading point can suit car sizes. Two small tubs may be loaded at once. *National Coal Board, Team Valley Trading Estate, Gateshead, Durham.*

AIR POLLUTION RECORDER

Rapid Operation



MARKETED under the name VISA (Visco Isokinetic Sampling Apparatus), this equipment is a production version of a system based on principles issuing from the British Iron and Steel Research Association's investigations into atmospheric pollution.

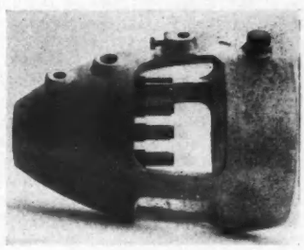
The apparatus is claimed to provide accurate and expeditious recording of dust, grit, and fume emission from stacks. Samples can, it is reported, be taken quickly and the filter may be changed within 30 seconds. The equipment consists essentially of a sampling probe, filter unit, cooling coil, pump unit, and instrument unit. A combined pitot tube and pyrometer is provided for measuring gas velocities and temperature.

Made of stainless steel, the sampling probe faces into the stream of dusty gas and a sample is withdrawn isokinetically. It is then drawn through a filter of pre-determined weight and cooled to ensure that corrosive liquids are not condensed in the sampling train. A gastight vane pump, equipped with a by-pass valve, expels the filtered and cooled gas sample through a gas flow rate indicator and an integrating meter. The filter is then reweighed, and the concentration is obtained by dividing this mass by the volume of the gas sample.

In order to sample isokinetically, the gas velocity and temperature in the stack are measured with the combined pitot tube and pyrometer and indicated on the gauge and millivoltmeter. Tables are then used which relate this gauge reading to the isokinetic sampling rate, which is maintained by operating a by-pass valve. *Visco Limited, Stafford Road, Croydon, Surrey.*

GAS BURNER

For Immersion Heaters



DEVELOPED with the co-operation of the Southern Gas Board, a new tube-firing gas burner for immersion heaters is announced.

This burner is claimed to meet the need for an efficient and inexpensive method of tank heating in all cases where immersion tubes can be installed. The burner is fitted to the tube extension outside the tank and is located by means of a set screw. Controls and gas supply are connected by easily-accessible joints. Gas at mains pressure is employed and fires around the inner circumference of the tube to prevent short-circuiting of cold air.

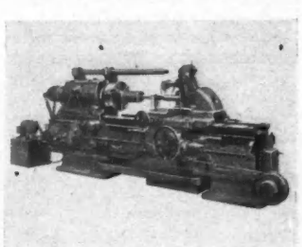
The burner, which has a cast-aluminium body, is available in a range of sizes; overall diameters are from $3\frac{13}{16}$ in to $7\frac{1}{2}$ in to fit tubes from 2 in to 6 in diameter. The burner length is constant at $7\frac{1}{2}$ in. The number of burners varies from 5 to 38. Gas connection sizes range from $\frac{1}{2}$ in to $1\frac{1}{2}$ in BSP, and maximum gas rates, measured at 3 in wg, from 75 to 570 cu. ft per minute. The immersion tube projection, before fitting the burner, is in all instances between $1\frac{1}{2}$ in and 3 in.

A pilot jet is fitted to the burner and there is provision for connecting a thermo-electric flame-protection device if this is required. A thermostatic control can also be employed.

It is anticipated that the burners will have an indefinite life but should attention to them be required they are easily and quickly accessible. These burners will be on show at the forthcoming Heating, Ventilating and Air Conditioning Exhibition, at Olympia. *W. H. Rowe and Son Limited, Quayside Road, Bittern Manor, Southampton.*

CENTRE LATHE

Suitable for Repetition Work



KNOWN as the HD Model, this new $10\frac{1}{4}$ in. centre turning, boring, and parting-off lathe is also designed to handle repetition work.

The bed is of heavy ribbed construction with a front slideway of the inverted-V type. The bed casting is of semi-steel and slideways are hand-scraped. If desired induction-hardened and ground slideways can be supplied. The standard model, illustrated, has a straight bed 10 ft 3 in long but a gap bed is available, enabling work up to 36 in diameter by $15\frac{1}{2}$ in width to be swung. The headstock with centralized gear-change control, has a range of 12 speeds from 16 to 453 rpm. When a wider range is required a two-speed motor can be fitted. Ground splineshafts carry the sliding gears; internal shafts and gears are made from heat-treated high-carbon or nickel-chrome steel. Gear clusters in the lower part of the headstock run in an oil bath; all bearings are pump lubricated. The hollow spindle, machined from a high-carbon steel forging, is mounted on taper-roller bearings at the chuck end and on parallel-roller bearings at the rear end. A multi-plate friction clutch is incorporated in the driving pulley.

There are 40 sliding and surfacing feeds, provided by a quick-change gearbox. The two toolholders may be operated in a combination of movements. A turret toolpost can be fitted at the front in place of the single toolpost. Swing over the saddle is 13 in. Tooling equipment includes a $3\frac{1}{2}$ in diameter by 4 ft long boring bar. The feed mechanism is protected against overload by a safety coupling. *The Crowthorn Engineering Company Limited, Atlas Works, Reddish, Nr. Stockport, Lancashire.*

XUM

New Ideas Coming in Time Measurement

Present-day requirements for the accurate assessment of time have been met both with the development of time-standard instruments of extreme precision and with a range of time measuring devices adopting ingenious and unusual principles.

A Report by the Federation of Swiss Watch Manufacturers

The atomic clock itself is on the left and on the right is a secondary unit called "l'horloge Universelle" which is connected to the atomic clock and indicates time in the main cities of the world.

For millennia, time has ruled man's daily life. Throughout the centuries, human beings have made repeated attempts to create a more precise time measuring device. The standard selected in the past has always been time which is a natural phenomenon, that repeats itself endlessly and invariably. The first time measuring instruments, such as the Egyptian sairis, the solar dial, the inclined surface, and the clepsydra, were all conceived according to natural time standards. With the development of technique, the wrist-watch and the clock have advantageously replaced these elementary time-measuring instruments. The time-measuring clocks which are used in our national laboratories are today's time-measuring standards.

ATOMIC CLOCK

It was established 30 years ago that the earth's cosmic rotation is subject to daily variations of about one thousandth of a second, and it could therefore not be considered as an absolutely perfect time-keeper. This conclusion led to the construction of quartz clocks, which are used now in all observatories. Ten years ago, however, watch specialists succeeded in making the first atomic clocks. The Swiss watch research laboratory of Neuchatel has been engaged for several years in a programme devoted to the development of these high precision clocks. A first model of the ammonia clock was completed in 1957, and exhibited at the Brussels Fair. A second improved model is now used in the Neuchatel laboratory, next to a caesium atomic clock.

In an atomic clock, the regulating function is performed by atoms or by molecules. Atoms and molecules oscillate at a frequency which is extremely rapid while the atom itself remains constant. Caesium atoms or ammonia molecules are used in atomic clocks. The higher the number of oscillations per second the more precise is the ensuing measure. Whereas the balance-wheel of a watch oscillates five times in a second, the quartz oscillation frequency can reach from 1,000 to 1,000,000 cycles per second; the oscillation frequency of the ammonia molecule reaches 24 billion cycles per second, and that of the caesium atom more than 9 billion.

Just as balance-wheel oscillations would stop very soon if they were not maintained by the watch spring, a comparable situation arises with atomic frequencies. The natural vibrations of the ammonia molecule or of the caesium atom are maintained through the impulsions of an electronic device, the amplification phases of which are cross-connected with the atomic frequencies.

CHRONOTOME

Since the quartz clock is itself a time-keeper subject to very few variations, the atomic oscillator does not have to run permanently. It may be plugged-in once a week, as is done in Neuchatel, in order to control the quartz clock performance. In order to ensure control of the atomic clock itself, an ammonia molecule clock and a caesium atom clock were installed in the Swiss watch laboratory; these two clocks are able to determine that the measured precision of one oscillator, compared to that of another, is within a range of about one millionth of a second a day.

A young team of the advanced research division of one Swiss watch company has just completed a miniature time-keeping quartz clock, the chronotome, which is almost entirely electronic, and which will certainly find many practical applications in various scientific and technical fields.

In addition to being used as a time-keeper on ships, it is also useful in the timing of seismic tests carried out in order to locate oil deposits. The chronotome can synchronize and control the entire automatic system of a meteorological base in the Atlantic. But for the time being, a first model is used only by a Swiss radio station for broadcasting abroad; the time-signal is piloted through a chronotome which is connected with the beams that are directed toward the receiving countries.

As in quartz clocks, which are the time-keepers used in Swiss national observatories, the regulator of this marine chronograph is a quartz crystal which has a very stable frequency. Once the vibration of the adequately cut quartz lamp has started, it can readily be maintained piezo-electrically, through an electronic system, as in any other watch balance-wheel which is set by hand, and the movement of which is then maintained by the regular clicks of the watch escapement.

Concisely, it may be said that the chronotome is composed of the following parts: an *oscillator*; a *frequency divider* with a division ratio of 600, so as to obtain from a quartz vibration (10,000 cycles per second in a chronotome), a frequency of 16⅔ cycles per second; and an *amplifier* which receives the information supplied by the divider, amplifying it in order to feed alternating current into the synchronous micromoter of the *time-signal*. The latter is therefore the only mobile part; its micromoter-controlled reduction gear provides for time registration. The circuits can be fed either by alternating 220V or 110V current, or by a direct current (battery) 6V or 12V source. The chronotome is designed in functional interchangeable blocks, and can be transported easily since its case is only 24·5 cm long, 13·8 cm wide and 10 cm high.

A small and transportable time-keeper of this type raises several temperature problems. There are about 15 transistors in the divider and in the feeding circuit, and these function adequately only within certain temperature ranges. Under the influence of temperature, the quartz frequency may also vary. In the present form of the chronotome, constant temperature cannot be maintained as is the case with the voluminous quartz clocks used in observatories. A correcting thermistance circuit has therefore been developed in order to offset and balance the quartz variations to some extent. In consequence, a chronotome which uses only 50 milliwatts at 20°C is guaranteed to function within a temperature range of 4°C to 36°C, at a precision nearing one hundredth of a second per day, and to have an autonomous performance (storage battery) of 200 hours (from 7 to 8 days).

"ATMOS" CLOCK

Although the "Atmos" clock is by no means a novelty, its source of energy is of interest. Temperature variations are collected through a gas contained in a metal case, the design of which is based on the bellows principle. Consequently, the gaseous expansion or contraction activates the motor-spring drum, first through the intermediary of a large spring acting as counterweight and registering the motion of the bellows-case, and then through a small chain locked with the spring. Motion is therefore transmitted to the spring-drum axis.

A mere temperature variation of one degree will wind the spring-drum spring for 48 hours. A completely wound spring-drum spring affords a 200 day power reserve. Ethyl-chloride is used since the steam pressure released by this gas is almost identical to the atmospheric pressure at a 12°C surrounding temperature.

CLOCKS POWERED BY LIGHT

Conceived in the same manner as the chronotome, the small photo-electric clock depends on natural or artificial luminous energy to maintain its mechanical movement. Six photo-electric cells convert the luminous photon beams into electric energy. The cells are set on a small 10 cm by 5 cm plate connected to a miniature 75 gm electric motor, which winds the spring. This micro-motor is made by the Patek Philippe laboratories and is designed as a permanent magnet type. Its rotating part is kept vertical, and the winding system is shaped in the form of a hood; the motor collector and brushes are made of precious metal. An illumination of 200 lux suffices to set it in motion; it can therefore function easily in a normally-lit room which requires 400 lux for reading and writing. Running at 1·25V, the motor consumes 0·5 ma and the spring is wound completely after half an hour; the winding is repeated several

times so as to ensure a steady spring power. The energy is transmitted through a speed reducing gearwheel, giving a ratio of 3,000 revolutions of the motor to one revolution of the spring.

Since the autonomous performance of the spring does not last more than 72 hours, a battery has been included in the mechanism; this takes over when the small clock receives no light to power it for more than three consecutive days.

A 1.3V mercury cell (shown removed, on the finger tip) will power the "Accutron" electronic timepiece for at least one year.

ELECTRO-MECHANICAL AND ELECTRONIC WATCHES

In this case, one is no longer dealing with a clock, but with a watch as thin as a chronograph. It was developed by the Ebauches S.A. research laboratories, and it is now manufactured by some 40 Swiss watch companies which are selling it under their own trade names. In the training centre opened by Ebauches S.A., foremen and manufacturing heads can familiarize themselves with the new assembling methods required for the electro-mechanical watch.

The mainspring is in fact eliminated and replaced by a motor in the electro-mechanical watch. On the other hand, the motor electric energy also maintains the oscillations of the "escapement" mechanism, which remains a mechanical device since it includes a balance-wheel. This type of motor comprises a ring-like stator, which is a rigid block of soft iron-sheet supporting a 17,000 turn coil that is completely embedded in plastic; a rotor, and a four-sectioned armature which is set on the balance-wheel. The balance-wheel oscillations are maintained electro-magnetically since with each alternation, a contact finger set on the balance-wheel axle touches the contact points and closes the electric circuit.

In the electro-mechanical watch, therefore, the wheel system is not driven by the spring, but by the balance wheel itself which sets its own rhythm. The balance-wheel oscillations are transmitted to the wheel system by a reversed lever ratchet mechanism. Except for the inversion mentioned above, the rest of the watch is of the standard type. The electro-chemical source of energy is supplied either by a 100 mah accumulator which the user of the watch can recharge himself, or by an easily interchangeable battery, not larger than an aspirin pill, and available on the market. The battery of a 15 micro-ampere watch, and consequently the watch performance, lasts about 10 months. The accuracy of such a watch is commensurate with that of a quality jewelled-lever movement, with an average tolerance of some 5 seconds per day.

The Patek Philippe photo-electric clock.

Other models of electro-mechanical watches have been developed, so that it can be said that this type of watch has reached the merchandizing stage. In fact, the original conditions set forth by Ebauches S.A. and by others are fulfilled. The watch is suitable for mass manufacture; it is suitable for large-scale assembly without modifications; it has a life-span of several months, and even of several years; and finally, it is designed simply, and can be adapted easily to the requirements of fashion.

The latest development in horological electronics is the introduction of the first all-electronic watch. This model, called the "Accutron," comprises a minute tuning fork, electronic components for circuitry and a train of gears to the hands. Differing from the conventional watch whose basis of time-measurement is the oscillation of a balance wheel, the "Accutron" uses the vibration of a precision tuning fork. It has only 12 moving parts compared with 19 in manually wound watches and its timekeeping ability is totally independent of lubrication. It has a "floating" gear train free from torque. The gears transmit movement only, there is no pressure incurred on them whatsoever, thus reducing bearing wear to a minimum. The oscillations of the tuning fork are maintained through a strong magnetic field in the space between the iron armature and the magnet. The vibrating fork induces an alternating voltage in the coil so that the tine of the fork is constantly attracted or repelled by the electromagnet. Through these isochronous oscillations the indication of time is carried out by a click mounted on one of the tines actuating a fine toothed ratchet. The ratchet turns forward one tooth pitch at each oscillation of the fork, that is to say, it is stepped forward separately one tooth per period, in this case every 1/360 second or 2·78 milliseconds.

Greater accuracy and general performance are obtained because the device is virtually unaffected by such factors as positional error, isochronal error or wearer's habits.

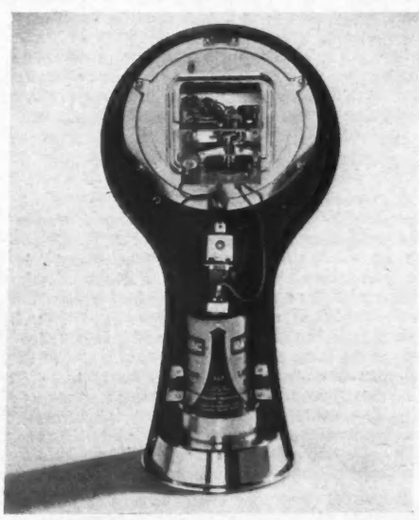
"SELTICON" TRANSISTOR CLOCK

The "Selticon" transistor clock seems to have gone one step ahead toward rationalization; above all, it constitutes one step forward in the field of electric watch systems. The creators of this clock understood that if they were to create a small clock capable of running continuously with accuracy and without having to be set for more than a year, they had to avoid the risks involved in the accumulation of the daily variations of the watch performance.

A watch mechanism driven electrically or even electronically was therefore developed. This mechanism, which has no contact whatsoever, eliminates bearings to the maximum, avoiding the resistance resulting from the wheel system, from the length of the hands and from the escapement. It eliminates finally the influence of the temperature variations, and the stress of the performing battery. The movement is called the electro-magnetic "Escap." It is composed of a cut-out expansion escapement and a polarized transistor micromotor without contacts. The movement is also equipped with a speed stalling mechanism acting on the impetus of the wheel system. The "Escap" is designed to correct the highly sensitive clock regulating lever within fractions of a second.

The size of this clock is not subject to more limitations than that of the electric watch. It is designed in three functional interchangeable blocks which are assembled by means of small locking levers, without requiring tools of any kind, and subsequent repairs will therefore be greatly simplified. The wheel system is set on the baseplate. Another plate supports the motor mechanism (which contains all electrical elements), a central stem with axis and pinions, and the block of the lever group, composed of the balance-wheel/spiral, the ultra-sensitive regulating lever, and the device periodically feeding the lever-fork by way of the motor-group. The electro-chemical source of energy is supplied by the usual 1·5V size battery.

The accuracy of today's timekeepers ranges from one to two seconds a day. Timekeepers that will be used in satellites may enable verification of the law of "general relativity," and may ascertain whether there is a variation of atomic frequency with respect to gravitation. These fascinating possibilities are being followed very closely by the Swiss watch industry.



Selticon: the new transistorized electro-magnetic time-piece; a 1.5V torch battery lasts two years.

Ensuring the Durability of Concrete

One of the inherent advantages of concrete as a material of construction is its durability. This can however be affected by many different factors, including chemical composition of the components and extremes of weather.

By P. W. Keene

Materials Department, Cement and Concrete Association

THE durability of concrete was the subject of a symposium organized by RILEM and held in Prague during August. The five sessions were nominally devoted to five different aspects of durability, but in practice there was a considerable amount of overlapping and rather than attempt to reconstruct each session selected topics will be mentioned individually.

Papers available well in advance were considered by the general reporter for each session, and some of them had been submitted early enough to be included in the *Preliminary Report* issued at the beginning of the Symposium. The remainder, and all other contributions and the discussion, are to be published in the *Final Report* next year. Since some of the contributors could not speak either of the official languages well and often defeated even the official translators, it was unfortunately not possible to follow everything that was said. A more complete assessment of the Symposium must therefore await publication of the final report.

Bond between Aggregate and Cement Paste

One of the most original and important papers of the symposium was a report by O. Valenta (Czechoslovakia) of tests on 4 by 4 by 16 cm beams cut from various types of rock. The beams were deliberately broken, and the separate halves used to make composite beams of the original size completed with cement paste (water/cement ratio 0·30 by weight). A tube was inserted in the cement portion along the axis of the beam for the purpose of measuring permeability at the joint. The composite beams were tested in various ways, for strength, permeability and resistance to freezing and thawing. Further tests were made with sawn and ground faces of rock at the joint between rock and cement paste.

The results showed that the rough rock surface left after fracture gave better bond and lower permeability than a smooth surface but, even so, the joint was always the weakest part of the composite beams. Low resistance to freezing and thawing was found with granite, limestone and one type of basalt, for all types of rock surface. The remaining aggregates, a dolerite, a quartzite, a greywacke and another basalt, gave better results but sometimes with wide differences in durability for the different types of rock surface.

Alkali-Aggregate Reaction

A comprehensive report from Denmark concluded with recommendations for avoiding alkali-aggregate reaction by using a special cement containing pozzolana, which improves the resistance to the reaction, or at least a cement with a low alkali content (less than 0·6 per cent equivalent Na_2O) or a sulphate-resisting Portland cement; alternatively by avoiding aggregates containing flint, and also by avoiding sea water or brackish water for mixing the concrete.

A new type of reaction involving a limestone aggregate, taking place only in moist conditions, was reported from Canada.

Air Entrainment

Principles governing the choice of substances for use as air-entraining agents were considered by Mlodecki (Poland). A paper by Jambor reported that, in Czechoslovakia, air-entrained concrete has recently been used on a limited scale for almost every type of construction, because of its improved workability and lower permeability. The agent used was a mixture of sodium salts of resin acids (air-entraining component) and sodium lignosulphonate (dispersing component). Earlier Russian tests were quoted to show that the resistance to sulphate and soft water had also been improved with air contents of 4 to 5 per cent of the volume of the concrete, but the resistance began to decrease when the air content was greater than this.

A greater quantity of entrained air than usual (10 to 12 per cent of the volume of the concrete) however, was recommended by Lyse (Norway) for concrete exposed to freezing and thawing in sea water, a more severe condition than freezing and thawing in fresh water. Concrete cubes with air contents within this range had greater durability, despite the reduction in strength to half that of cubes without entrained air. These tests may have some significance for concrete roads when salt is used for removing ice, though, of course, caution is necessary in applying the results of such laboratory tests to the conditions of exposure met in practice.

Kowalski and Sloniewski (Poland) gave details of a frost resistant grout for post-tensioned cables made by entraining air to the extent of 10 per cent by volume of the water used in mixing the grout.

Tests for Freezing and Thawing Resistance

The difficulty of relating laboratory tests to practice was emphasized in a history of the development of tests for freezing and thawing given in a paper by Arni and Blaine (United States).

The four standard tests in use since 1952 differ in the rate of freezing and thawing, and in the degree of saturation during the test, and are referred to briefly as the rapid-water, slow-water, rapid-air and slow-air methods. Results of these tests, obtained in a number of laboratories, showed that the rapid-water method was the most severe and distinguished rapidly between concrete of high durability and concrete of lower durability. The slow-water method made the same discrimination but took longer to produce the results. The rapid-air method gave less consistent discrimination than either of the tests in water. The slow-air method, the least severe of all, detected inferior quality of aggregate, but did not detect inadequate amounts of entrained air.

Laboratory tests may be used to determine the relative durability of different kinds of concrete, and are used now almost entirely for assessing the quality of aggregates, but there is no means of using the tests for deciding between acceptable concrete and concrete to be rejected for any particular field condition. The paper concluded with an unanswered question. Do the laboratory tests reproduce, in accelerated form, conditions met in practice, or is the nature of laboratory testing entirely different in some way from exposure in practice? Is the difference between laboratory tests and practice therefore simply a matter of degree, or is it a question of kind?

Powers has suggested an alternative method of test in which the specimen is first allowed to dry out before being soaked and frozen. The changes in length of the specimens are measured during the test. Preliminary results, as yet unpublished, of Tremper and Spellman, using a similar method to the one suggested by Powers, are reported to be promising but it is not yet clear whether this test reproduces more closely than the other tests the conditions of exposure encountered in practice.

Super-Sulphated and Slag Cements

A few authors discussed the durability of concrete made with slag cements. Babatcher and Pentcher (Bulgaria) reported that the durability of slag cements was better than that of Portland cement in solutions of magnesium salts. Gaca (Poland) reported that slag cements were unable to resist the combined chemical and frost attack encountered in maritime works. Conflicting opinions, e.g. Kunszt (Hungary), on the durability of slag cements were thought to be due to differences in the quality of the slag used in each particular case. Another important factor was the age at which tests were made. Pollitt (Great Britain) produced evidence to show that concrete made with super-sulphated cement was stronger than that made with sulphate-resisting Portland cement when immersed in sulphate solution up to about four years, but the strength subsequently fell and was lower after immersion for about eight years.

Frost Resistance

Wallis (Sweden) gave a summary of a report to be published later this year, discussing the theory of frost resistance based on the degree of saturation and presenting a limited amount of experimental work which supported the hypothesis. In another paper dealing with the same topic, however, Schulze and Altner (East Germany) showed that the range over which a similar theory applied was limited and not of any practical value at present. They concluded by saying simply that requirements for frost-resistant concrete are: the lowest possible water/cement ratio, the lowest possible cement content, the correct quantity of entrained air, and an aggregate grading to give the maximum density with the lowest possible specific surface.

Steam Curing

Kunszt (Hungary) showed that the rapid changes in temperature accompanying steam-curing sometimes caused cracks which reduced frost resistance, but when cracking was avoided there appeared to be little difference in durability between normal and steam-cured concrete. Tests reported by Shestopyorov (USSR) showed that the effect of steam-curing on frost resistance depended on the cement used and the quality of the concrete.

Miscellaneous

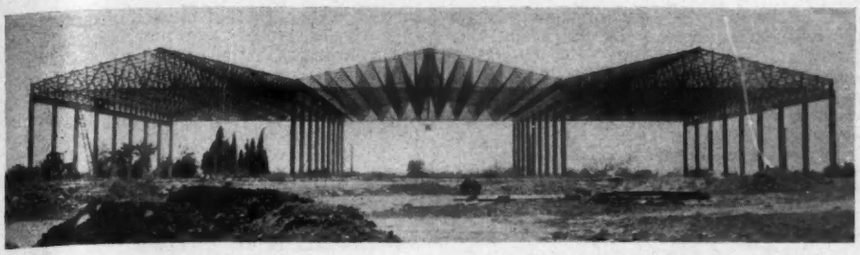
Kondo (Japan) gave results of tests on mortar showing that shrinkage and tendency to crack increased as the fineness of the cement increased.

A paper by Taylor (Australia) summarized experience of all types of treatment for concrete floors, for the most part already published elsewhere.

A contribution from Holland demonstrated how widely paints vary in reducing the permeability of concrete, emulsion paint being less effective than oil paints, which in turn were less effective than resins of various types.

Contributions by delegates from Great Britain included one by Halstead (Cement and Concrete Association) on durability in general, Snowdon (Building Research Station) on shrinking aggregates, Wright (Road Research Laboratory) on the frost resistance of concrete kerbs, and Keene (C and CA) on kerbs damaged near joints in a concrete road.

Other papers dealt with creep, the durability of high alumina cement, the durability of pumice concrete, and biological attacks on concrete.



Warehouse Roof of Slotted Angle

Dexion slotted angle has been used to build the framework for a warehouse roof for a large firm of beer and soft drink manufacturers in Athens. The roof comprises three 60 ft spans and is to be covered with corrugated aluminium sheeting. Columns and beams are of reinforced concrete and the total length of the warehouse is 156 ft.

Slotted angle sections are easily sheared to size and the members can be bolted together quickly by unskilled labour with very little supervision; construction costs are therefore kept down. Locally available cladding materials can be used with such frameworks.

Dexion Limited, Overseas Division, Beresford Avenue, Wembley, Middlesex.

Embankments Built in Pulverized Fuel Ash

Pulverized fuel ash is a waste product resulting from the use of finely ground coal in power stations. In 1947, ¾ million tons of this ash were produced; in 1960, 6 million tons. The difficulties of disposing of this "waste" are considerable, though use has been made of the material for land reclamation (see last note).

At the Central Laboratory of George Wimpey, a lengthy series of tests has been carried out to determine the physical properties of the material, as produced at Carrington Power Station, to assess its suitability as a fill material for the construction, for example, of highway embankments or as a fill beneath structures. The details of the tests and the conclusions are given in No. 16 of *Research and Application*, the broadsheet issued by the Central Laboratory at Springfield Road, Hayes, Middlesex, and from whom copies may be obtained.

The report emphasizes that it is important to distinguish between two types of ash residue: the fine grained ash that is carried into the flues and recovered from the precipitators; and the coarse and gritty ash which is formed as a deposit in the boilers and furnaces. The former, when dry, is easily blown about and is commonly known as fly ash.

An existing tip at Carrington, which contains both the fine and coarse material intimately mixed, has been built up over two years, the ash being loosely dumped and spread by bulldozer. At one time, when the tip varied from 20 ft to 25 ft high, the side slopes were as steep as 45°, giving valuable evidence of the natural stability of the material. Investigation showed that the ash was generally suitable for the construction of embankments.

At Manchester some road embankments have already been built using the ash, including the approaches to a bridge. These approaches have a combined length of 3,200 ft and a maximum height of 18 ft; the top width is 48 ft for a 30 ft carriageway; the side slopes are 5 in 4 (horizontal to vertical). Near the abutments the ash is stabilized with cement. The ash was spread in 9 in layers by bulldozers, which gave some initial compaction, followed by ten passes with a 10 ton pneumatic tyred roller. All slopes were grassed to prevent erosion, but before the grass came through it was necessary to prevent the surface drying out, otherwise the fines were blown away.

After construction, a trench for a sewer had to be cut through one embankment; the walls of the trench stood vertically, a pick was required to cut the sides and it was observed that the ash had become slightly cemented.

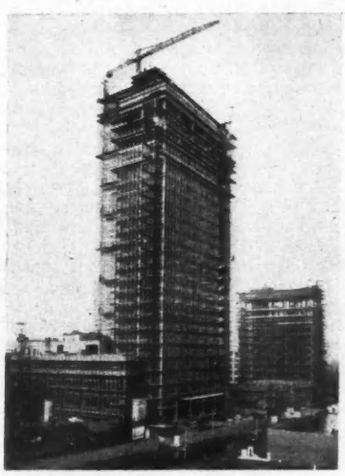
The embankments have behaved satisfactorily since they were built 18 months ago.

Britain's Tallest Building

Britain's tallest building—400 ft high—is being built in Manchester by John Laing Construction Limited. The traditional topping out ceremony was held on Tuesday, 12 September. It will provide office accommodation for the Co-operative Insurance Society Limited.

Of steel frame construction, the CIS tower block will have 550,000 sq. ft of floor area; there will be 25 floors with a five storey podium and a three level basement. An adjoining service tower of reinforced concrete, clad with Italian mosaics, will be the same 400 ft high. The highest tower crane in Europe, a Jules-Weitz G60, 456 ft from base to top, is being used in the construction of the building.

The project also includes a separate 14-storey office block of reinforced concrete construction;



At 400 ft, the new Co-operative Insurance Society's building in Manchester will be the tallest in Britain.

between the two office blocks there will be a conference hall to sit 1,000 people. With the exception of the service tower, the buildings are clad with curtain walling, consisting of glazing and black anodized aluminium panels.

The buildings are to be fully air-conditioned, with air filtration, electrostatic precipitation and humidity control. Engineering plant will also include eight fully automatic express passenger lifts, a goods lift, and ten reversible escalators. A special installation will be an automatic vertical chain conveyor—the first of its kind in the country—for the rapid distribution of documents and mail. The kitchen and cafeteria in the main block will be equipped on most modern lines to serve 2,500 meals over two hours.

Work on the project, which is being carried out for the Co-operative Insurance Society Limited, began in August 1959 and is due for completion by the middle of next year. The superstructure and a major part of the cladding has now been completed and about 500 men are engaged upon the final phase of the contract, which includes a great variety of finishings.

Grooved Surfaces Give Improved Braking

Grooves at close intervals have been cut across the surface of some concrete runways in an attempt to increase the braking efficiency of aircraft. By this means it is hoped to avoid the expense of lengthening the runways to accommodate faster and heavier aircraft.

The technique of surface grooving can be applied to roads to provide extra tyre grip, particularly at corners. Grooving can also be used to give warning of approaching hazards, for there is said to be a distinct change in tyre noise when passing from a smooth to a grooved surface, though the spacing of the grooves is insufficient to cause vibration of the vehicle.

Initial experiments indicated that grooving was effective, and trials were carried out at Wittering airfield by the Air Ministry to find most efficient and cheapest method. The most satisfactory machine tried proved to be a British made Clipper Consawmatic. Unlike other machines under test the Clipper used a sawing action instead of beating the grooves by a flailing action: thus the surface was not damaged and the aggregate in the running surface was left undisturbed. The grooves were also found to be firmer than those made by a flailing method and well able to resist wear and weather.

As the depth of the sawcut can be controlled to within close limits, it was also felt that the Clipper method might assist with the drainage of the surface film of water which tends to lie on a runway. This would reduce aquaplaning.

Just prior to the Farnborough Air Show the main runway there was "grooved." The grooves are ¼ in wide by ¼ in deep and 1 in apart; in all 1,980 miles of groove were cut over 870,000 sq. ft of runway and the task was completed in 18 days using six Clipper Consawmatic self-propelled machines each carrying 12 reinforced silicon-carbide blades which enabled 12 grooves to be cut at one pass. The contractor for this work was T. C. Stewart (Contractors) Limited of Bury St. Edmunds, Suffolk.

Preliminary reports say that the grooving was very satisfactory and performed as expected.

Agricultural Land Reclaimed with Fuel Ash

Pulverized fuel ash has been successfully used to reclaim marshland for agricultural purposes. Ash from Connah's Quay power station, on the Cheshire-Flintshire border, has been pumped into the local marshland on the banks of the River Dee, and the water drained off through filters into the river. As soon as the ash reached the rim of the lagoon, the area was ready for levelling, sowing and cultivation.

The first ten-acre experimental area which has been used in turn for arable and grazing purposes has proved remarkably productive. Some of the root crops are reported to have been conspicuously successful; cereals have not been of an equivalent standard, but it is thought that good crops will be obtained as soon as more humus has had time to permeate into the ground. Grass and clover have grown prolifically.

The initial success of the scheme has encouraged the creation of another 57 acres which will be ready this autumn, and another 70 acre area is to be tackled later this year.

Other examples of agricultural land being obtained by the deployment of fly ash are some low lying land around the river Stour in Kent, where grazing land has been restored, and in the Midlands, at Hams Hall, Birmingham, gravel pits have been back-filled with the ash, recontoured and sown.

These uses of fuel ash are reported in Central Electricity Generating Board's Newsletter No. 14 for August, 1961.

XUM

Reservoir Control Uses GPO Lines

The Sheffield Corporation Water Works has commissioned a new remote recording system which allows the depth of a reservoir six miles away to be read on a control panel.

A depth detector at the bottom of a 13 ft deep reservoir measures variations in water depth by fluctuations of pressure on a diaphragm. An adjacent unit contains a bridge network which sends an electrical signal over GPO lines to the control room six miles away at the pumping station where a strip chart recorder is installed to receive the signals. In the case of failure, the chart instrument will show a reading of over 14 ft, thereby indicating a fault in the measuring unit.

The installation does away with the necessity of a daily visit to the reservoir to measure the depth of the water, and all necessary adjustments to the water supply are made from information given on the chart. The transmitter unit at the reservoir is checked weekly.

The total cost of the system was less than £400. Even allowing for rental of the GPO wires, this gives a considerable saving. The remote recording scheme was designed and installed by Honeywell Controls Limited at the request of Mr. A. B. Baldwin, M.Eng., general manager and engineer of the Sheffield Water Undertaking.

Honeywell Controls Limited, Greenford, Middlesex.

2,400 MW Station Opened on the Volga

The 2,400 MW hydroelectric power station at Stalingrad on the River Volga has been formally opened. It will send out up to 14,000 million kWh annually. A 500 kV transmission line, 625 miles long, is already completed to Moscow and an 800 kV line is under construction to the Donbas. The power station has 21 generating sets, each developing 115 MW. It is probably the largest hydroelectric station now operating.

The dam is built in an alluvial plain and the 375 mile long reservoir will supply water to irrigate several million acres of agricultural land as well as providing water for the turbines.

The Stalingrad station is one of a chain being built on the Volga; two other large stations completed since the last war are at Gorky and Kuibeshev—the latter being rated at 2,300 MW and for some time the largest station in the world. Two more are under construction, at Saratov and Votkinsk, and four more are to be built within the next ten years at Cheboksary, on the Lower Volga, and on the Upper and Lower Kama. The combined capacity of the Volga and Kama plants will be 60,000 million MWh annually.

It is also reported by the agencies that drawings are complete for the first Soviet tidal station. The capacity is said to be only 1 MW but the station is planned for completion by 1964 and will be on the Kola Peninsula, near Murmansk. Others are scheduled for completion by 1970.

Motorway Construction in Britain

The current rate for bringing new motorways into operation in Britain is 6½ in per minute, so reports the latest communication from the Roads Campaign Council. In the 1001 days from December 1958—when the Preston By-pass was opened—to 1 September this year, 148¾ miles of motorways have come into service. The construction costs are put at £54·4 million.

Under construction at the moment is another 144 miles at an estimated £76½ million. About 300 miles of motorway will have been opened by the end of 1963 and the cost will then have been £132 million, but there can be little doubt that this sum will already have been saved by the first of the motorways. The Council estimate that, altogether, 928 miles of motorway are planned for the country by the Ministry of Transport.

Quoting the last Road Research Board annual report—that by 1980 there will be 25 million vehicles on Britain's roads (2½ times today's figure) and 34 million by 2000 AD—the Council point out that motorways should be designed and built with a view to enlargement. "It would be a national scandal if the taxpayers' money is wasted on roads outflanked by the meteoric rise in traffic," a Council spokesman commented. The plea that the Government should also give immediate priority to spending more [on roads] in urban districts was repeated.

Impact of New American Roads

A new highway into or around a community may well produce far higher values than the construction process destroys. This is true even for segments of the community which may at first sight appear to be adversely affected.

This is one of the conclusions reported by 12 economists and engineers in a publication just issued by the Highway Research Board of the National Research Council in the United States. HRB Bulletin 268, *Some Evaluation of Highway Improvement Impacts* describes the effects of new highways on municipal planning, location of industry, community growth, land uses and land values.

Some of the findings are:

The average industrial concern does not fully realize the total economic impact of modern roads on business operations.

A small number of roadside enterprises are adversely affected by new by-passes, but most are not and may even benefit to the extent that a by-pass frees local streets for the movement of shoppers.

The value of both improved and unimproved farm land of all kinds is usually boosted.

New urban expressways have a measurable effect on the distribution of population and the nature of land use, but its full influence may not be felt for from four to eight years.

Although the authors developed their contributions independently, most of them reached the conclusion that considerably more research on highway impact is required and that the results of such efforts will enable planners to locate and design highways which will contribute more to community development than a mere speed-up in traffic movements.

Bulletin 268 may be obtained from the Highway Research Board, 2101 Constitution Avenue, Washington 25, DC, USA ($2·60).

Surface Drainage on Motorways

Attention is drawn in the last annual report of the Road Research Laboratory—*Road Research 1960* (HM Stationery Office, 7*s*)—to three problems relating to the drainage of motorways.

Significant amounts of water are often found to be retained on the surface of the carriageways for considerable periods after rain. This loose water is a source of danger and inconvenience. It results in sprays of water being thrown up by fast vehicles, it reduces visibility at night, and it can result in dangerous patches of ice in cold weather. To determine how this trouble can be minimized, an experimental length of carriageway is to be built at the Road Research Laboratory to study the effect of cross-falls and the roughness of the surface.

The second problem relates to roadside drains. There are considerable differences between the specifications for drainage arrangements for major roads in rural areas. Some of the systems may be inadequate and others over-designed. A study is to be made to clarify the point.

The third investigation is concerned with culverts, particularly the design rate of water flow through them. The construction of motorways is proving to involve a large number of culverts, and hydrological investigations will be carried out in conjunction with the Hydraulics Research Station in three catchment areas. It is quite possible that new water flow measuring devices will have to be evolved for the work.

One Storey Every Week

New Zealand House in London, now under construction, has a four-storey podium—or lower block—topped by a fifteen-storey tower block. The framework for the tower was completed in 17 weeks, at the rate of one floor every 7½ days, to a height of 229 ft. The contractors are Holland & Hannen and Cubitts who plan to have the building completed in June, 1962.

The framework consists of circular reinforced concrete columns cast *in situ* on a 27 ft grid and mainly *in situ* reinforced concrete beams and floors, though there are some precast beams in the tower block. Throughout the building there is no span of less than 27 ft except where the lift shafts intervene. The beams are generally an integral part of the floor slabs and over the reception area they span 54 ft and are 6 ft deep. Up to 12 ft of the main structural columns were cast in single lifts using circular steel shuttering. These columns have a diameter of 42 in at ground level and diminish approximately 3 in every two or three floors to 15 in at the top of the tower block.

Throughout the tower rapid hardening cement has been used to permit a quick turn round of shuttering, and high tensile steel has been used for all the shuttering. Columns in the tower block and the two lift shafts were cast to full storey height at a time. The shuttering for the lift shafts was prefabricated and the tower crane was used to put it into position as required. Similarly, the scaffolding that supported the shuttering for the main perimeter columns was prefabricated and hoisted into position.

The building is carried on 48 concrete bored piles, 6 ft 6 in in diameter and sunk to depths of between 97 ft and 107 ft below pavement level, making them among the deepest foundations ever constructed in London. The largest of these piles support loads up to 1,700 tons. Of the 48 piles, 26 were built in hand excavated shafts and the remaining 22 in machine bored shafts that were inspected by lowering closed circuit television cameras into the bell-shaped bases of the excavations. Around the perimeter of the site there is a retaining wall which incorporates a water cut-off reaching down to a depth of 50 ft below pavement level.

Designed by Robert Matthew, Johnson-Marshal and Partners, New Zealand House brings a new concept in architecture to London's West End. The podium, or lower block, reaches to a height of 60 ft which conforms with the general cornice level of the neighbouring buildings. The tower block is set back from the pavement line to maintain the scale of the street. There will be over 220,000 sq. ft of office space, and a car park of 9,000 sq. ft in the basement reached by a ramp running round three sides.

The building has a basement and a sub-basement, a ground and lower ground floor, a mezzanine and lower mezzanine floor and 18 stories above. It will be fully air conditioned throughout the year and kept at an even temperature. There will be double glazing in the podium but single glazing in the tower; no window will open, apart from those in the tower and then only to permit cleaning, for it is intended that the sealed windows shall exclude fumes and traffic noise from the streets outside.

The consulting engineers for the structure are Scott and Wilson, Kirkpatrick and Partners, Victoria Street, London SW1, and the consultants for the services, J. Roger Preston and Partners, Malet Street, London WC1.

Holland & Hannen and Cubitts (Great Britain) Limited, 1 Queen Anne's Gate, London SW1.

Companies

Steel Company's Storage Problems

SOME millions of items, from small screws to heavy machines, are required to be kept in store to meet the needs of the rolling mills and workshops of the STEEL COMPANY OF WALES LIMITED at Margam and Port Talbot, and further increases in these quantities were rendered necessary by the company's extensive expansion plans.

Large-scale replanning of the stores was first considered as long ago as 1957. At that time, some £2¼ million worth of equipment was held in stock, covering nearly 80,000 sq. ft of floor space in the main bay of the stores at the firm's Abbey Works, at Margam Works, at the Ffrwdwyllt store and in two locations borrowed from other departments. This accommodation was already proving inadequate and proposals were put forward for the erection of a new stores building, estimated to cost about £250,000.

An exhaustive survey undertaken by the material handling division of FISHER AND LUDLOW LIMITED, Tipton, Staffordshire, resulted in recommendations that a system of palletization, in order to make use of hitherto wasted air space, would provide the best solution.

It was necessary that each pallet should be able to take a load of up to 3 tons and, to allow for stacking up to six high, the pallets had to be constructed to sustain loads of up to 18 tons. For spares which could not be accommodated on pallets owing either to their weight or shape, or to both, the use of specially made racks and cradles was required.

The adoption of special Fisholow post-type steel pallets, employing the standard 6 ft by 4 ft frame, but with extension posts adjustable for heights up to 6 ft 2 in according to the equipment to be carried in them, were recommended.

Palletization Brings Order and Efficiency

Originally, the scheme provided for 4,640 pallets and about one thousand racks and cradles; half of which were to be used in the proposed new stores building at Ffrwdwyllt, thereby providing a 40 per cent increase in storage capacity for a 17 per cent increase in floor area.

However, after further study of the problems involved, it was decided that the new building could be dispensed with and storage needs met by the use of pallets in the space already existing, after obtaining new storage locations in a crane bay and at an old tinplate works known as King's Dock, Swansea, for very heavy and slow-moving stock.

In the revised scheme, the maximum use is made of the main bay at the Abbey Works and of the existing store at Ffrwdwyllt. Palletization has now reached an advanced stage at these premises, with 1,500 Fisholow pallets in use at the Abbey Works and about one thousand at Ffrwdwyllt. As the scheme progresses, one thousand more pallets are being brought into use at these two places.

It has also been decided to use pallets at the electrical store at Abbey Works, where 675 pallets, designed for this purpose, are being supplied for the storage of electric motors of various sizes. These machines were previously stored in fixed tubular racks.

At both Ffrwdwyllt and the Abbey Works, the pallets are arranged four deep and up to five high in blocks on either side of a broad gangway. Narrow aisles are provided between the second and third rows, in order that the smaller items of equipment can be obtained by hand by storekeepers with ladders, without having to move the tiered pallets.

How well the introduction of palletization has brought about an increase in order and efficiency is clearly indicated in the accompanying illustrations.

Expandite's Confidence in the Future

In spite of some reduction in certain of the firm's profit margins, the board of directors of EXPANDITE LIMITED, producers of jointing materials and sealing compounds, remain confident that the overall trading position of the group will remain satisfactory.

Contributory factors of the decline in profit margins have been a fall in demand in the motor and domestic appliance industries, keener competition and the effect of the wet weather during last year's summer on the building industry.

Nevertheless, the consolidated trading profit of the group amounted to slightly over £273,000 for the 52 weeks ended 1 April, 1961, compared with just under £260,000 for the 53 weeks ended 2 April, 1960. However, after deducting amounts attributable to minority interests, the group net profit for 1960-61 only slightly exceeded that for the previous year, mainly because of increased taxation.

Dividends for the year ended 1 April last are being effectively maintained at a total of 10 per cent, less tax, on the doubled ordinary capital of £500,000, as against dividends totalling 20 per cent on a capital of £250,000 in the previous year.

The group's chairman, Mr. Bertram Watson, reminds his shareholders that the conservative dividend policy has been maintained as was foreshadowed in December last, because the directors believe this policy to have been one of the primary factors in the company's expansion over the past five years, and that it is essential to ensure their continued future growth. The dividend is covered nearly four times by profits.

Exports the Key to Prosperity

Political and social unrest have tended to disrupt trade but this fact, Mr. Watson emphasizes, has not deterred Expandite from increasing the emphasis on exports and overseas developments.

Those who are concerned with exports, however, get little encouragement from the Government. It will be a memorable day for this country, Mr. Watson feels, "if and when" the Government are sufficiently courageous to translate their "words of exhortation into action." Yet, in spite of the measures recently announced by the Chancellor of the Exchequer, which may reduce the buoyancy of the group's sales and bring further pressure on profit margins, Expandite's board remain confident of the group's overall trading position.

As to their overseas subsidiaries, Mr. Watson says that the directors believe that overseas income from the firm's exports, earnings from overseas subsidiary companies and royalties from local manufacturing arrangements will all make an increasing contribution to the group's profits.

An Expandite company has been registered in Holland, and a modern factory is under construction at Harlingen where many of their products will be manufactured for supply to certain parts of Europe. This new company, together with Secomastic SA in Belgium, and other existing manufacturing arrangements in Europe, will give the group a good position, Mr. Watson feels, in the Common Market.

Plessey Take Over the SPE Company

An announcement by the PLESSEY COMPANY LIMITED, Ilford, states that they have acquired the whole of the share capital of the SPE COMPANY LIMITED, Slough, from BOOKER BROTHERS, MCCONNELL AND COMPANY LIMITED. Although the price to be paid for this acquisition has not been disclosed, it is understood to be in the region of £500,000.

The SPE Company is a subsidiary of the PULSOMETER ENGINEERING COMPANY LIMITED, which was recently taken over by the Booker group in conjunction with G. AND J. WEIR HOLDINGS LIMITED.

Products of the SPE Company, which lie outside the principal ranges of the Booker group's own pump interests, comprise aircraft fuel pumps and associated equipment. These pumps are, however, stated to be complementary to the extensive range of fuel pumps which the aircraft mechanical division of the Plessey Company have been producing for many years.

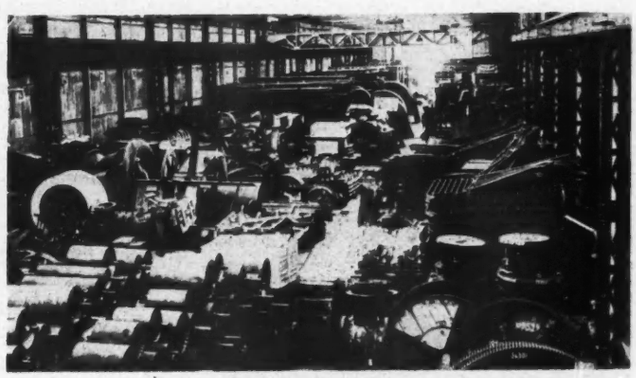
SPE, the statement adds, will continue to operate autonomously, but within the Plessey group, and no changes are likely to be introduced, either in the firm's manufactures or marketing policies, at any rate in the immediate future.

Enfield Cables and AEI Get Together

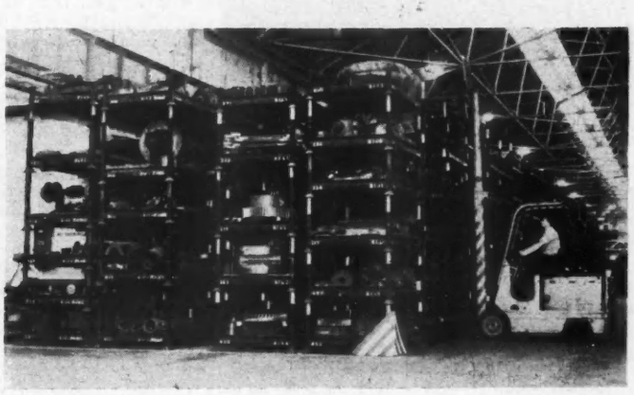
Arrangements have now been completed by ASSOCIATED ELECTRICAL INDUSTRIES LIMITED and ENFIELD CABLES LIMITED for the transfer of all their business in paper insulated and polythene insulated telephone cables, and in coaxial and other high-grade cables for telecommunications to TELEPHONE CABLES LIMITED, Chequers Lane, Dagenham Essex.

Telephone Cables, who were formed in January of this year and are a subsidiary concern owned jointly by AEI and Enfield, are now handling all home and export business in this field for both principals.

They claim to be the largest suppliers of telephone cables to the British Post Office, and carry out extensive trunk cable installations for that government department.



A section of the main stores of the Steel Company of Wales at Ffrwdwyllt prior to their reorganization.



Neatly-stacked rows of pallets replace sprawling floor-covered areas. A section of the same stores after the introduction of pallets.

Flame Sprayed Metals and Ceramics

There is nothing inherently new in flame-sprayed coatings but these examples show the size and variety of work now being undertaken with such materials.

FLAME spraying with one of several pieces of equipment on the market is now an established process for building-up worn or incorrectly machined parts. One firm who offer such equipment are Metco of Woking, and part of the range of metals which can be sprayed using $\frac{3}{16}$ in wire and acetylene gas on one of their Type K machines is shown in the table on this page. Costs in this table are shown in shillings and are for metal, gas, oxygen and compressed air. Metco say they do not include labour, overheads, handling or surface preparation, since these items vary with individual applications.

In recent years, a gun for flame spraying materials in powder form has been introduced by Metco and this enables ceramics such as alumina and tungsten carbide with a cobalt binder to be applied very economically. Within the last year they have further launched a plasma spray gun which enables almost any known ceramic that melts or softens before it dissociates, to be applied by spray. This last piece of equipment is reputedly very expensive with regard to control equipment, and the coatings—such as tantalum carbide—have not as yet any wide practical applications.

The applications on this page do show some of the large and varied work which is being undertaken in this country with the Metco materials and equipment. It is worth noting that most of the coatings can be made to adhere to a whole range of underlying metals. Thus Metco comment that an interesting development over the past few years is where light-weight or fabricated rolls are flame sprayed with, say, copper or stainless steel with advantages in cost, weight and performance.

Metco Limited, Chobham, Woking, Surrey.

Babbitt Bearing Shell

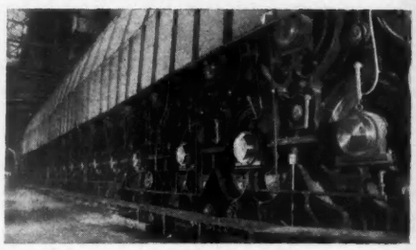
The illustration above shows a bearing shell being flame sprayed with Sprababbitt A in the works of A. J. Seward (Engineering). This type of bearing may vary in size from 20 to 42 in with a shell thickness of $\frac{1}{4}$ to 1 in.

The deposit of babbitt metal applied by spraying is said to provide a surface with a substantial reduction in the tendency to "wipe." A metal-sprayed coating, being porous, retains lubricant and in service gives an extended life over conventionally poured bearings. Additional advantages claimed for the coatings include freedom from voids and gas inclusions and of segregation of constituents.

The procedure adopted by A. J. Seward (Engineering) is as follows: (1) prepare the surface by machining 24 threads per inch with a 10° radius on the nose of the tool. (2) Preheat surface to 90-100° C usually by passing the flame spray gun over the surface without the wire feeding. (3) Apply a 0·002 in thick coating of Sprabond wire as a bonding coat. (4) Deposit Sprababbitt A to a radial thickness of 0·135 in; this will allow 0·010 in for finish machining. (5) Finish turn to size.

Journals and Roll Surfaces

Contained in this paper-mill dryer section are almost certainly more metal sprayed areas than on any other single piece of machinery in the world, say Metco. Every journal on both ends of the 38 dryer section rolls has been sprayed, and many of the roll faces are sprayed with stainless steel, giving nearly 100 areas of sprayed metal on this one machine. The alternative would have been to reduce the diameter, fit undersize bearings and replace the gear.



Maintenance Build-Up

Flame spraying in maintenance is illustrated on the left, in the works of Jenkins Motors, where a press-crank is being built-up on the pin and journal diameters. An all-purpose alloy, Metcoloy No. 2 is mostly used for this type of work. Jenkins Motors say that the owners of this crankshaft report that the durability as rebuilt by metallizing is superior to that of the original.

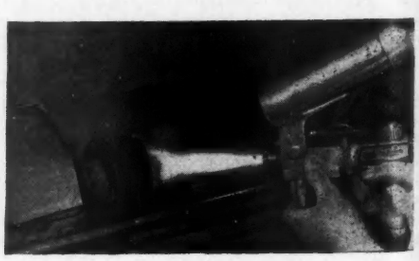
After an initial coating with Sprabond wire, the deposition of steel is continued to a little over finished size to permit grinding to required dimensions. Since the coating thickness is virtually unlimited and the material to be sprayed can be any metal in wire form, comment Metco, this cold process is found in most maintenance workshops today. An installation such as this would comprise gas and oxygen regulators and flowmeter, a compressed air regulator and filter, and the metallizing gun.

Hard Facing with Tungsten Carbide

In cases where materials (such as some metals, ceramics and cermets) are expensive or difficult to produce in wire form, they can often be flame sprayed using powdered material, say Metco.

The illustration shows a plug gauge blank being sprayed with Thermospray powder 34F, a tungsten carbide blend developed for this purpose, by EST (Gauges). The surface had been previously grit blasted. After spraying, the blank is heated to 1,050° C to fuse the deposit within itself and to the base material, giving a homogeneous coating which Metco claim is completely alloyed to the blank. The piece can then be heat-treated if it is required to provide a hardened core, without affecting the carbide coating. The gauge is finish ground.

A feature of this system of manufacture, Metco add, is that when reconditioning is required the gauge blank can be rebuilt by a few thousandths of an inch, reground and put back into service. This can be repeated as often as required.



Characteristics of Metco Sprayed Coatings

Metals	Consumption per hour			Coverage 0·001 in thick, sq. ft per hr	Wire weight for 1 sq. ft 0·001 in thick, lb	Materials cost per sq. ft 0·001 in thick, shillings
	Lb of wire	Cu. ft of gases				
		Oxygen	Acetylene			
Metco aluminium	15·8	82	39	1,124	0·014	0·062
Metco SF aluminium	19·8	80	39	1,404	0·014	0·062
Metco copper	27·4	79	40	575	0·048	0·193
Metco nickel	16	79	39	326	0·049	0·645
Metco zinc	61	84	41	1,235	0·050	0·097
Metcoloy 1 (18Cr-8Ni-stainless steel)	17·8	79	39	391	0·046	0·335
Metcoloy 2 (High-Cr-stainless steel)	17	79	39	384	0·044	0·371
Sprabond wire (molybdenum)	7·8	88	42	147	0·053	3·48
Sprabronze AA	24	82	40	502	0·046	0·45
Sprabronze TM	36	82	40	735	0·049	0·356
Sprasteel LS (low shrink)	18·4	89	33	391	0·047	0·398
Sprasteel 25	18·4	89	33	448	0·041	0·10

Using Tapes Instead of Paint

One of the largest gas producing plants in the North of England is reported to have experimented with a black pvc self-adhesive tape made by Rotunda of Manchester, to replace painting.

This company say that due to the acid laden atmosphere in the plant, metal handrail supports along gangways and inspection platforms had to be repainted continuously as no paint system could withstand the destructive effects of the atmosphere for more than 3 or 4 months. A full time painter was employed whose sole function was to keep the handrails protected.

After two years the tape and handrails are said to be in excellent condition. The tape made by Rotunda was about 0·009 in thick and was applied to a surface which had been thoroughly cleaned to remove scale or dust.

In another application aluminium sheeting was to be bolted to a galvanized steel framework. The galvanized framework was protected by pvc tape and Rotunda say that there have subsequently been no signs of galvanic corrosion.

Rotunda Limited, Denton, Manchester.

Resin Bonded Fabric Bearings

United Coke and Chemicals Company have introduced an addition to their range of Orkot resin bonded bearings which can withstand heavy radiation. Such bearings are needed in atomic power stations where in some applications they also need to operate without oil or grease lubrication and remain unaffected by immersion in "pond" water.

Known as Orkot TL, the bearing material is reported to have undergone extensive testing and to have been specified for the bearings for the fuel element handling equipment at both Hinkley Point and Sizewell atomic power stations.

The makers say the material is tough, hard wearing and has a low coefficient of friction with aqueous lubricants. For dry running conditions, it is available impregnated with graphite or molybdenum disulphide. Grade TL is dimensionally stable in the presence of water and has a remarkably high resistance to radiation damage, say United Coke, as shown in the following table.

Dosage, megarads	Change in edgewise compressive strength, per cent
100	45
300	22
1,000	—17

Other mechanical properties are: compressive strength, flatwise, 49,000 lb per sq. in; compressive strength, edgewise, 15,000 lb per sq. in; impact strength, 20 ft-lb per in; flexural strength, 10,500 lb per sq. in; flexural modulus, $0{\cdot}5 \times 10^6$ lb per sq. in.

United Coke and Chemicals Company Limited, Handsworth, Sheffield 13.

Helically Welded Aluminium Pipe

Helically welded aluminium pipe is now being offered in sizes from 6 to 28 in diameter with wall thicknesses up to ¼ in by three British companies: Apitubes, Bristol Aerojet, and the British Steel Piling Company. Apitubes are producing pipe on helical-weld equipment designed and built at their Jarrow-on-Tyne works; Bristol Aerojet have developed a different type of machine which produces a helically welded tube to close tolerances for more specialized applications; and the British Steel Piling Company are operating a Driam helical-weld machine at their Claydon Works, near Ipswich.

Alcan Industries say that for all trials on helical-weld machines in this country they advised on machine adaptation and supplied Noral strip up to ¼ in thick. Their associates, Aluminium Laboratories, fitted the MIG and TIG welding equipment and established correct welding procedures.

Alcan Industries comment that welding is faster with aluminium than with steel and the high speeds possible lead to a high rate of output and low manufacturing costs. The role of aluminium in pipework could now be reassessed because it can now be obtained in a wider range of sizes and often at a lower cost than that made by other processes.

Alcan Industries Limited, Banbury, Oxon.

Pvc Pipe For Effluent Line

Recently, T. B. Ford, the manufacturers of blotting paper and filtration media, of High Wycombe, decided to replace their effluent disposal system. Previously effluent had been carried from the factory in a series of wooden troughs. The company wanted a material that had a better appearance, was easy to install and could be used out-of-doors without the need for maintenance. They chose pipe in Geon

high-impact pvc made by Extrudex of Bracknell.

At one stage the system passes over a stretch of water several yards broad and it was essential to use a material that could cross this gap without the support of elaborate bridging. (One of the support structures can be seen in this illustration). In this respect, pvc pipe offers considerable advantages over competitive materials due to its combination of strength and light weight, say British Geon. They add that the cost of a pvc pipe was less than that of stainless steel or rubber lined pipe, the possible alternatives.

In all, some 800 ft of 15 in diam. pipe have been installed. British Geon say that T. B. Ford report that they are very satisfied with the installation and plan to use pvc pipe in other parts of their plant.

British Geon Limited, Devonshire House, Piccadilly, London W1.

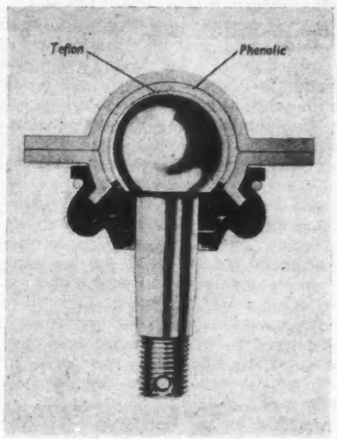
Ptfe Dry Bearings to be Made in UK

A range of dry bearings whose properties are derived from an anti-friction surface of woven ptfe fibres is going to be made in the UK by Engineering Productions (Clevedon). This company has been evaluating products of this sort for 18 months, especially those made in America by American Metal Products Company under the name Fiberglide. The new range will be made under licence.

The illustration shows the construction of one of these bearings as applied to a spherical suspension ball joint. Around the steel ball, which is surface finished by honing to about 10 micro-in with less than 0·0003 in sphericity error is a thin layer of woven ptfe fibres. These fibres are made by Du Pont in America from their Teflon product. Between this surface and the pressed or forged metal housing is an injection moulded layer of phenolic resin incorporating combinations of glass fibres and cotton duck whose function seems to be to strengthen the resin, to hold the ptfe surface in position, and to act as a barrier layer.

Engineering Productions say they will be offering these ball joints ready made-up. They have already established quite a large demand for their variety of joints which have nylon bearing surfaces and these, they say, are extensively used by British Motor Corporation and the Rootes Group. Although such joints will be sold as "greaseless joints" they may in some instances contain a small amount of lubricant whose main job will be to prevent corrosion.

The following data were obtained by the American company on a spherical bearing of about 1¼ in diameter. The company say that at the end of the tests all the Fiberglide bearings were operating satisfactorily although some units showed a considerable wear pattern. Engineering Productions say they would support the test figures.



Oscillating Tests with Spherical Bearings

	Load, lb per sq. in	Angle of oscillation, degrees	Cycles per min.	Total cycles, 1,000's	Results
Fiberglide	25,000	40	40	300	Satisfactory
Steel ..				—	Seized at start
Fiberglide	1,000	12	480	15,000	Satisfactory
Steel ..				15	Failed
Fiberglide	3,000	60	60	1,000	Satisfactory
Steel ..				400	Failed
Fiberglide	12,000	20	20	1,000	Satisfactory
Steel ..				60	Scored

Engineering Productions (Clevedon) Limited, Clevedon, Somerset.

Lubricants Safe with Oxygen

A lubricant which is claimed to be safe when used with oxygen at high pressures and temperatures is being made in America by Hooker Chemical Corporation and distributed in the UK by Omni (GB) Limited.

Fluorolube LG, as it is called, is a solid oil polymer of chlorotrifluoroethylene. Hooker say it is suitable for use under normal temperature conditions as a thread sealant and valve lubricant on oxygen handling equipment. In laboratory tests Hooker laboratories are reputed to have shown that this material is resistant to degradation or attack by oxygen at 2,000 lb per sq. in and up to 300°C. This requirement conforms to Military Specification Mil-C-5542. The presence of aluminium and brass powders is said not to affect the stability of the lubricant.

Omni (GB) Limited, 35 Dover Street, London, W1.

XUM

Changing Patterns of Machine Tools

On the evidence of this month's Seventh European Machine Tool Exhibition, the major current advances in machine tools are in the use of control equipment. In the machines themselves, however, there have also been developments in unit construction and in basic design and layout.

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THE recent machine tool exhibition held at the Palais du Centenaire (see Figs. 1 and 2) in Brussels from 3 to 12 September was the seventh to be organized by the European Committee for Cooperation of the Machine Tool Industries, which was formed in July, 1950. Paris, Hanover and Milan have also been venues for the exhibition, which is held every two years.

The opening ceremony was performed by M. Brasseur, the Belgian Minister for Foreign Trade and Technical Assistance, who welcomed the visitors and spoke warmly of the benefits of international cooperation, particularly in Europe, where the volume of trade between members of the European Economic Community has increased some 50 per cent in the two years 1958/60, while imports in 1960 increased by 20 per cent compared with 1959. The numbers employed in the machine tool industries of the ten member countries of the European Committee total approximately 200,000, and the machines on show represented about one week's output.

It is of especial interest, in view of recent developments concerning the entry of Great Britain into the common market, that the President of the Committee this year, and the first British President, was Mr. Robert W. Asquith, who made the point in his opening speech, "Just as the European Machine Tool Committee itself provided a pattern for other industries to follow, so also the UK industry hopes that its steps may be followed by those whose work lies in the higher, or at least different, plane of political activity."

The British Machine Tool Industry became a member of the Committee in 1953, in which year also the exhibition was held in Brussels. Some indication of the way the exhibition has grown over the years can be obtained by comparing the numbers of machines on show—over 4,000 this year, compared with 2,500 in 1953.

CONTROL DEVELOPMENTS

At the present time, the countries of the Common Market are headed only by Australia and India in the list of customers for British machine tools; the value of exports to this market was £3·6 million in the first six months of 1961.

The largest number of exhibitors was from Germany, with 285 (36 per cent), out of a total of 782, followed by France with 159 (20 per cent), Italy with 90 (12 per cent), Switzerland with 86 (11 per cent), and Great Britain with 70 (9 per cent). Other countries exhibiting were Belgium, the Netherlands, Austria, Sweden and Denmark.

Probably the main development that was in evidence at the exhibition was the growing use of numerical and programme controlled machine tools. Since there is some confusion in the terminology, it may be as well to define these two terms before proceeding to illustrate their application. Numerical control is taken to mean the automatic positioning of a machine tool directly from numerical information without the intervention of a human operator; the storage of information is usually by tape, punched or magnetic, or by punched card.

The term "programme control," although it could be used to include numerical control, is usually taken as referring to some type of automatic sequence control in which the end of one operation is used to initiate the next. This tends to limit the motions to basic machine movements such as, for example, sliding and surfacing, but it has the very great advantage that the control functions can be supplied by means of a plug board at a relatively low cost.

In the field of numerical control, it is quite evident that the British manufacturers of control equipment have a clear lead. This is illustrated by the linking up of British control equipment manufacturers with Continental machine tool manufacturers; Ferranti were exhibiting their control equipment operating a French Huron milling machine, while EMI cooperate in a similar way with the German company, Droop and Rein. Another new tie-up, and one of the surprises of the show, is that between EMI and David Brown, who are showing a tape controlled six station turret co-ordinate drilling machine, which is illustrated, together with its control unit, in Fig. 3. This latter unit, the Emicon B100 Positioning System, is itself on show for the first time and may be used with leadscrew driven or direct slide movement measuring units.

Numerical control is also being applied to measurement and inspection of components and there are indications that certain applications, such as to rotary tables, have been warmly welcomed by industry. Probably the most highly developed system on show was the High Precision Equipment universal automatic co-ordinate measuring machine, which was fitted with the Ferranti point to point positioning system. This particular combination, illustrated in Fig. 4, can measure automatically in three axes within an overall capacity of 72 in by 36 in by 15½ in, while the claimed accuracies are within 0·0005 in in the X and Y horizontal axes, and within 0·0002 in in the Z vertical axis. Provision can be made for a continuous digital display of position on all three axes together with automatic print-out of information if required. This new approach to the measurement of three-dimensional forms, which was developed originally for the measurement of aircraft models at the Royal Aircraft Establishment, offers the possibility of rapid and reliable checking of the complex forms which the numerical control of machine tools makes feasible, and which is at present a tedious and time consuming process.

Turning from numerical control to programme control, one finds that in this particular field Continental manufacturers have made a big effort and a large number of different examples are on show. One machine which illustrates the fundamental approach of Continental manufacturers to design problems is shown in Fig. 5. This is a capstan lathe fitted with programme control using an electronic-hydraulic system; the plug board for selecting the various sequences of the operations can be seen at the right hand side of the machine, making a very neat and compact unit assembly. However, examination of the machine tool itself will show that the bed has been turned through 90° about a horizontal axis from the generally accepted position and it is claimed that this feature, which is also present on a number of other machines at the exhibition, helps to clear the swarf, prevents it from interfering with the operation of the tools and makes the tooling itself more accessible. Since one of the main advantages of programme control is reduced setting time and hence increased machining time, it is clear that the above factors have become relatively more important.

UNIT CONSTRUCTION

Unit construction of machine tools and equipment is another feature in evidence on several stands at the show. It is now possible to purchase hydro-pneumatically operated units for drilling and tapping operations, which will execute a fully automatic cycle and can be used as unit construction elements in the building of special-purpose machines and manufacturing

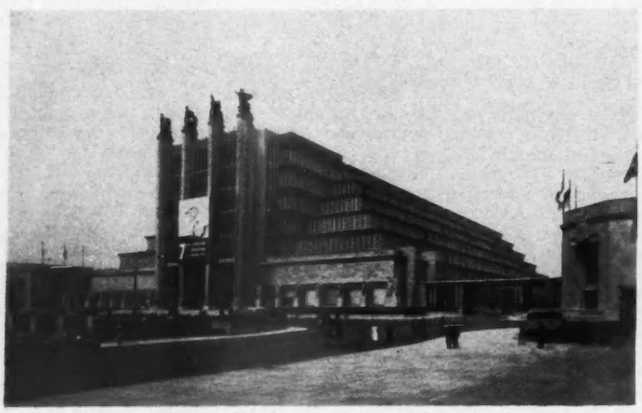


Fig. 1 The Palais du Centenaire, Brussels, where the Seventh European Machine Tool Exhibition was held this month.

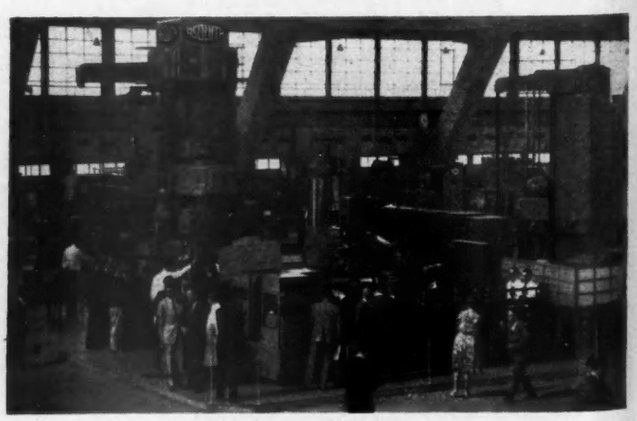


Fig. 2 Inside the exhibition. There were 782 exhibitors, of whom 70 were British, and a patio and gallery were used as well as the main hall.

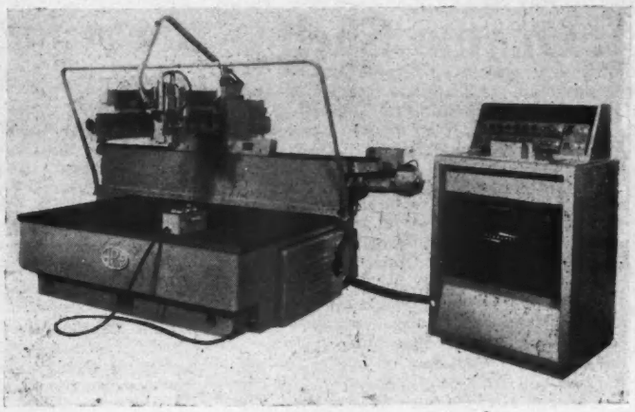


Fig. 3 (Left) A David Brown six-turret co-ordinate drilling machine which is tape controlled by the Emicon B100 Positioning System.

Fig. 4 (above) The Ferranti point to point positioning system in use on the High Precision Equipment universal automatic coordinate measuring machine.

lines. However, probably the most interesting development of unit construction is the Heinemann Komplemat 225 which is presented as a multi-purpose turning machine that can be assembled from unit construction elements into a multi-tool, profile copying or turret lathe while a form of programme control is incorporated into the basic headstock unit. An extremely unorthodox feature of this machine is the use of prefabricated concrete in the fabricated base as a means of ensuring rigidity.

With the growth in the use of automatic operation of machine tools, it becomes even more essential to provide rapid and reliable means of loading and unloading of workpieces. There is evidence among the stands that a good deal of effort is now being put into making the whole cycle of operations fully automatic. For example, Fig. 6 illustrates an automatic set-up on a Churchill grinding machine; the complete cycle, which involves loading, grinding, measuring with an electro-sizing gauge and unloading, continues automatically as long as components are available. The loading device is of the magazine type, which is suitable for a set-up where one operator is looking after two or more machines; the components are carried in clips attached to an endless belt and automatic indexing is performed by an air operated mechanism.

Another way of tackling the problem is by means of multi-purpose feeding machines and one example is a system developed by Pfaff which it is claimed offers a means of continuous feeding of all production machines on which cylindrical workpieces are machined in continuous sequence.

It will have been noticed that in many of the successful pieces of automatic equipment, mechanical, electric, hydraulic and pneumatic units are used in one combination or another to obtain the best and most economical form of operation. A very large number of attachments is available to enable basic machine tools, such as lathes or milling machines, to be made automatic even if only in a very limited manner. A popular way of tackling this "low cost automation" as it tends to be called, is by means of hydraulic or pneumatic relays and actuators. Examples of these relatively cheap and effective systems could be seen in operation in all parts of the exhibition halls since the simplicity of the controls coupled with their general robustness and ease of servicing helps to make them a very attractive and successful way of introducing control equipment into the smaller factory. Familiarity with this type of equipment will, it is to be hoped, ultimately lead to the installation of more complex and sophisticated control systems in all types and sizes of factory since only by the more widespread use of automatic equipment can costs be reduced and prices lowered.

Finally, a word on the appearance of the machine tools at the exhibition; although the majority are much as before except for odd attempts at "cleaning up," which are often spoilt by the addition of unrelated measuring and controlling equipment, there are some indications of a new look. This look could well be termed the "square look," as will be apparent from examination of Fig. 7 from which it appears that the machine tool industry may be following the lead of the car industry. However, the attempt to produce aesthetically related forms, together with a more widespread use of attractive colours to define the various operational areas of the machine tool may well result in future exhibitions, and factories, taking on a much more pleasant and more colourful aspect.

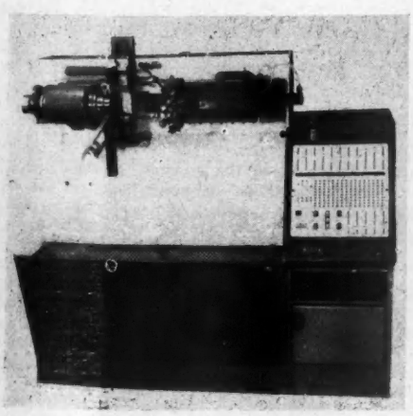


Fig. 5 With its bed in this position, this capstan lathe is more easily tooled and cleared of swarf.

Fig. 6 Automatic loading and unloading of workpieces on a Churchill grinding machine.

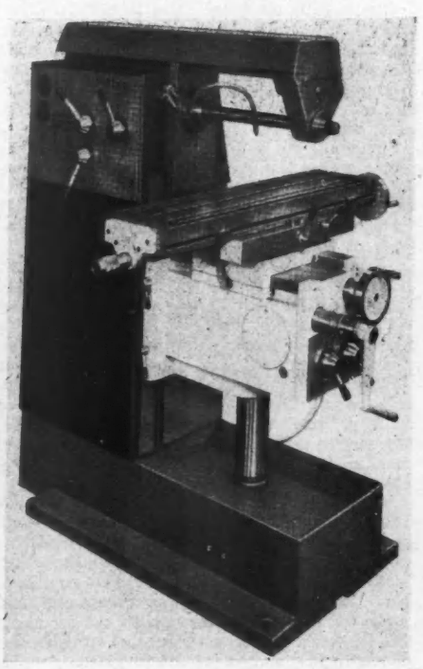


Fig. 7 The Viking Universal Miller, an example of the new "square look" in machine tools.

On the Shelf

By Frank H. Smith

If anybody hasn't yet got the hang of what's happened to the British Empire I suggest they get from the Ministry of Information (the only address I can find is London, which to my mind is the last word in Information) R.F.P.4944 Classification III.1 (for which they had to send out a corrigendum from 4934) which is entitled *The Monarchy and the Commonwealth*. There must be some significance in the fact that Her Majesty is known in this country as "Elizabeth the Second, by the Grace of God of the United Kingdom of Great Britain and Northern Ireland and of Her other Realms and Territories Queen, Head of the Commonwealth, Defender of the Faith," but in Nigeria she is simply "Elizabeth the Second, Queen of Nigeria and of Her other Realms and Territories, Head of the Commonwealth." I wonder where we come in that second title? The Central Office of Information (again—London) also puts out *Fact Sheets on the U.K. Dependencies* and the specimen I have is on Zanzibar. Very useful if you happen to want a job there. For instance, you learn that the languages you'll need to know are Kiswahili, Arabic, Gujarati and English. I'll try and get by on the last.

Addison Wesley Publishing Co. of Reading, Mass., make it easy for you again in their 1961 catalog (sic). The two centre (or should I say center?) pages list their latest at three levels—Introductory, Intermediate and Advanced; three columns divide the books into mathematics, physics, engineering science, and yet another column enumerates prerequisites (high school maths., calculus, advanced maths., etc.). The rest of the catalogue follows the same helpful line.

A guinea seems rather a lot (10*s* 6*d* to members) for 54 pages but that is what you can get *Report of the Proceedings of the Linguist in Industry—A Symposium* for from the Institute of Linguists, 3 Craven Hill, London W2. This, it seems, was "the first known occasion on which linguists and industrialists have met together to discuss the problems of translation and interpreting needs . . ."

This is quite amazing. The National Engineering Laboratory (East Kilbride, Glasgow) think that more than one copy of their *Research Summaries* may facilitate circulation and offer to supply further copies. I've been impressed by their information service ever since I first came across it.

Something for nothing department. Magnesium Elektron Ltd., Clifton Junction, Manchester, do a booklet "Protection and Surface Treatment." Tucked inside my copy was a chart "Mechanical Properties and Chemical Compositions of Magnesium Alloys."

I think I have mentioned before, the periodical directory run by Publishing & Distributing Co. Ltd. (Mitre House, 177 Regent Street, London W1) and I've now had two booklets, the 13th edition of *Overseas Directories, Who's Who, Press Guides and Year Books* and *Overseas Advertising—The Far East*. The first is 80 pages at 7*s* 6*d* and lists 600 directories in abc order of country, and with advertising rates given. The second is one in a series of six (6*s* each) and they are reprints from the annual *Overseas Newspapers and Periodicals*.

We live and learn (if we're humble enough). The National Coal Board issue standard specifications; I assume they are so specialized that it is not worth while for the British Standards Institution to cover particular items such as No. 253, hooks for shunting poles, and 254, brake sticks. All the same, I do wonder about 252 (hacksaw blades) or 258 (steel straightedges of rectangular section) or 259 (engineer's ratchet braces and drilling pillars). There are one or two others I would query if I dare, but with winter's approach I don't want my coal stopped.

Fans for the Designer

Axial Flow Fans: Design and Practice. By R. A. Wallis. *George Newnes*. (50*s*)

A new book on this subject fulfils a long felt need, as despite the advances in axial flow fan and compressor designs since pre-war, there is no up-to-date work on the subject. Although the author covers the whole field of axial fan design, installation and testing, it is the sections on design that are most interesting.

The main advances in this type of machine have been to increase the work output by using a greater number of blades on the fan spaced closer together. The result has been that each blade interferes with the aerodynamic operation of its neighbours, and it has been necessary to evolve design methods that can allow for these "interference" or "cascade" effects. In this book both design methods are developed, that is the isolated aerofoil theory (neglecting interference effects) and the cascade method (considering interference effects). Basically the isolated aerofoil method used is that of Dr. Patterson, while most of the cascade data quoted are by Howell and Carter; however, there is much that is original. The flow in an axial fan is essentially a vortex flow and both "free vortex" and "forced or arbitrary vortex" flows are considered. The former assumption yields a simpler design but the latter is useful for some special cases. The methods described are applied to fans without guide vanes, as well as to fans with guide vanes placed before or after the rotor.

In addition to a full description of each method of design, enough information is given for the reader to undertake for himself a fan design. Some very helpful worked examples of fan design are included. One gets the feeling however that the author prefers the cascade method of design whenever possible.

The book contains subsidiary sections on variable pitch fans, methods of fan testing, noise, and an appendix on propeller fans. In addition there are introductory chapters on the elementary theory of aerofoils, boundary layers, dimensional similarity, and flow in ducts which will be mainly of interest to students. The text is well supplemented with charts of data on aerofoils, cascade blading, and design criteria. A separate list of notation and a good bibliography are valuable features.

The book requires little specialized knowledge to understand. It should appeal to fan engineers, lecturers, final year students and those desiring to enter this field for the first time. There is also much of common interest to axial pump designers.

Altogether this book is worth buying for those interested in fluid mechanics.

I. S. Pearsall

Wings Stretch Ideas

Progress in Aeronautical Sciences. Volume 1. Edited by Antonio Ferri, D. Küchemann and L. H. G. Sterne. *Pergamon Press*. (80*s*)

Aircraft Instruments. By C. A. Williams. *Odhams Press*. (35*s*)

Principles of Inertial Navigation. By C. J. Savant, Jr., R. C. Howard, C. B. Solloway and C. A. Savant. *McGraw-Hill, New York and London*. (76*s*)

Oliver Wendell Holmes once said something to the effect that, "a man's mind, stretched by a new idea, can never go back to its original dimensions." This stretching of the mind under the impact of new ideas is vital to the engineer, whose responsibility it is to re-shape Nature for human purposes.

Unfortunately we live in an age of increasing specialization which means that, in truth, we tend to learn more and more about less and less. For the engineer, living at high pressure in a specialized world, there is little time left in a day for the broad reflection that is the foundation of creative thought. Under these conditions it is more important than ever that vision—which is the basis of the creativeness which marks the engineer as a man apart—should be supplied by books which cast their nets wide for new ideas, and then impart them in a form which is easily digested.

With this basis in mind we come to the first book entitled, appropriately enough, *Progress in Aeronautical Sciences*. The book has been produced as the first in an authoritative new series by the Pergamon Press, their aim being to produce annually a similar volume of specially commissioned articles, which will provide for the specialist a survey in breadth of recent work in his particular field, while providing the general reader with some idea of developments in fields other than his own.

The first article, "On the Principles of Aerodynamic Design," is by E. C. Maskell of the Royal Aircraft Establishment. In it he outlines the course that aerodynamics has taken, from the early, classical, subsonic aeroplane (which relied for low drag upon a wing having a relatively large span compared with its chord—and called high aspect-ratio), to the slender, arrow-like, wings that are being planned today for flight at supersonic speeds.

The author very neatly sets the scene for the rest of the book, but it is a pity that his all too short article does not include the occasional drawing. If, as the publishers state, one intention of this kind of book is to acquaint the general reader with knowledge outside of his own sphere, then one diagram which quickens the interest is worth a hundred words of explanation.

The Royal Aircraft Establishment is also represented by two other authors, whose articles are relevant to some of the practical aspects of structural design and aircraft operation. Of these, one, by D. Williams, deals with the vital problem of pressure-cabin design, the study of which was high-lighted by the tragic Comet accidents and the inquiry which followed. Mr. Williams deals lucidly at some length with the design of windows and cut-outs; and the analysis of Mansfield's "neutral hole," which is the origin of the elliptical window, is presented neatly and concisely for its own merits. Where they appear, diagrams are clear and to the point.

The other article from the R.A.E. is by C. H. E. Warren and D. G. Randall, on the theory of the supersonic bang, which is associated with the sudden rise in pressure and temperature through a shock wave over a distance of the order of 0·0012 in. It was found that the sonic bang is propagated along a ray and under certain flight conditions, due either to changes in the flight speed and path of the aircraft or to non-homogeneity of the atmosphere, the rays can be bent. Some of the rays may intersect, which causes a focusing of the bangs and this increases the intensity of their effects. Although the theory of sonic-bangs is not yet complete the arguments are well put in plain language, are clearly supported by mathematics, and summarize much of what is now known.

Hypersonic flight, which is flight at speeds in excess of five times that of sound or something of the order of 4,000 mph, is represented by an article dealing with the dynamics of an ionized gas, presented by F. A. Goldsworthy of the University of Manchester. In it he ranges from the shock-tube as a tool in the study of high-temperature gas characteristics, through equilibrium and non-equilibrium theories, to the treatment of shocks in inter-stellar gas.

The remaining three articles are in their

original languages, two in French and one in German.

The first French article, by Robert Legendre, deals with the calculation of blade-profiles in turbo-machines having transonic flow. The method is built up in detail from basic methods of calculating types of flow in the presence of blade-lattices; an approximate analysis is outlined and developed, through the use of a hodograph, to give the final transonic flow condition.

The second French article, by M. Fenain, is concerned with the theory of homogenous potential flow and its application to the calculation of supersonic wings. The theory, which is presented neatly and in great detail, is applied to slender wings and non-slender swept wings with constant profiles. Other applications of the theory are, for example, to conditions of steady pitching and rolling, or when it is necessary to introduce coefficients to approximate data, or to satisfy conditions of moment or volume which are applied to hypothetical wings in certain lifting conditions.

The German article, which is by E. Becker, deals with unsteady boundary-layers behind compression shocks and expansion waves. Various classes of unsteady boundry-layers, which occur when compression and expansion waves travel along fixed plain walls, are introduced, together with their counterparts in shock-tubes and tubular wind-tunnels.

Both laminar and turbulent boundary-layers are considered in great detail, and the article is generously supported by 80 references.

The book is well produced and compact. It has both subject and author indexes and each article is supported by a separate bibliography. The only criticism is that it is aimed rather more at the specialist, who already knows much of what is likely to be said, than one might have wished for in a work of this kind. However, as a first volume, it sets a high standard and we look forward to the second in the series. It might be better for the less specialized reader, who in some respects is more important than the specialist, if future volumes could include good translations of any foreign articles, as well as the occasional diagram which relates a particular work to some practical application.

It is impossible to measure any variable in flight, be it speed, pressure, temperature, or acceleration, by any direct method without having to apply corrections; and this makes the design of accurate aircraft instruments of fundamental importance to the science of aeronautics.

The second book, entitled *Aircraft Instruments*, by C. A. Williams, is a handbook of mechanical and electrical general-purpose instruments used in aircraft. It explains, in simple terms with plenty of diagrams, the working principles of most of the instruments used in modern aircraft.

Each instrument is dealt with in a self-contained section in which its operating principles, construction, calibration, testing and maintenance are described.

Part I of the volume deals with mechanical instruments, including the gyroscope, which revolutionized instrumentation when it was introduced. It is a pity that, in order to simplify the description of the gyro, Mr. Williams should have fallen into the usual trap of mixing force and momentum vectors in one diagram. However, this is a minor error compared with the wealth of interesting information that he manages to impart.

Part II is concerned with electrical instruments and includes chapters on remote-indicating systems, fuel-gauges, electrical gyroscopes, speed and temperature measurement.

Part III deals with test procedure and equipment.

All told, a tremendous amount of up to date information has been crammed into this comparatively small book, without any sign of cramping. Diagrams are clear and to the point, print is clear and, at the price, the book is well worth buying.

The final book, on *Principles of Inertial Navigation*, is well up to the usual McGraw-Hill standard, although it is a pity that these books have to be so highly priced.

Briefly, inertial-navigation is the modern man's expensive way of avoiding getting lost—or, as a navigator prefers to put it, being temporarily uncertain of his position. Instead of using reference datums such as landmarks, the horizon, the sun, moon and stars and inserting such variables as the speed of the wind and tides into his calculations, he is now developing the gyro-stabilized datum, about which he can measure accelerations in any plane, and which, when integrated twice, give him his position in terms of distance from a set of reference axes pre-fixed in space.

The need for such sophistication is man's journeying into a third dimension. The rapidity with which inertial-navigation has advanced is due to man's need to carry war with him wherever he goes. Inertial-guidance, which is based upon inertial-navigation, lies at the heart of the long-range missile.

The book covers a wide range of practical and theoretical studies. Having started as a series of lectures to graduate engineers it has the right approach from the first page, and develops logically into three distinct areas.

In the first it covers the basic problem of navigation and leads into the elements of automatic navigation, by way of Newton's laws and discussion of intertial-navigation systems.

The second area covers practical aspects of the design of auto-navigational components and computers, platform-controllers, ground-alignment and pre-flight testing.

The third area of the book covers the mathematics of inertial-navigation. This seems to be an eminently sensible way of doing it, because it is all too easy to frighten the more practically minded reader by introducing mathematics too early in a discourse. A set of useful appendices is included, together with an index and a reasonable bibliography.

The visual impact of the book is good and, in a sense, rather understates the extent of the work that it covers. This is felt to be a good thing, because no book is good in the fullest sense if it gives the impression that it will be hard to read, no matter what excellence it contains.

D. STINTON

Moon Journey

First Men to the Moon. By WERNHER VON BRAUN. *Frederick Muller.* (13*s* 6*d*)

This is a somewhat difficult book to review inasmuch as it appears to be addressed primarily to the younger teenager. It consists of about 100 pages but large margins are left for explanatory material and diagrams where required. Basically it describes a fictional voyage, the first apparently, to the moon by two American Astronauts (this book was first published before the Russian flight successes). The story, however, is a mere vehicle for the dissemination of a surprising amount, considering the length of the book, of technical information on all aspects of space science. In addition it is profusely illustrated with diagrams which although simple are very effective. The explanatory material is interspersed among the main story line and although by doing it this way attention is drawn to it more effectively than if it appeared in an appendix, it does tend to a somewhat confused layout.

In an introduction to the book von Braun answers certain basic general questions on space research and travel that are constantly being asked by the layman. It appeared to me, however, unnecessary to have introduced religious sentiments here, especially in view of von Braun's association with V2 rockets.

The story line itself is written in a style that can only be described as belonging to the better class boy's magazine and is also rather "stiff upper lip" in parts alternating with laboured jocularity. In addition a liberal sprinkling of Americanisms in the dialogue might tend to irritate the British reader.

Apart from this criticism, however, the account of the voyage is as authentic as present knowledge allows, as might be expected from an author of such reputation. The problems associated with the initial injection into orbit, the subsequent routine of the flight proper and the ultimate descent on to the surface of the moon are well presented. Also the account of the necessary but rather dull from a fictional point of view, schedule of tests and experiments on the moon show a refreshing departure from the pseudo scientific fiction seen on television recently. The author could not resist a final mishap, however, a defective air lock prior to take off, on the return journey, but it did have the effect of drawing attention to the tight time schedule necessary for such an enterprise. Incidentally, the finding of a small electronic canister, a remnant of a previous moon probe, within walking distance of their rocket seemed to carry coincidence a little too far.

Summarizing, I consider that the book as a whole, for its price, is very good value to anybody with little or no knowledge of this subject, in particular the scientific bent 15 or 16 year old schoolboy, who requires a sound basic account of the problems of space flight. Such a person probably would not be over concerned about its literary style.

C. R. TURNER

Tooth Geometry

Introduction to the Kinematic Geometry of Gear Teeth. By ALLAN H. CANDEE. *Chilton Company, 56th and Chestnut Streets, Philadelphia 39, Pa.* ($12.50)

Twenty years ago the gear engineer, recognized as such, was almost unknown. Very few manufacturing concerns making gears as part of the product employed a full-time gear man; why should they, when their junior draughtsmen learnt all about gears at technical school, and there's a copy of the well-known *Handbook* in the office? So, they got by. The gear machine makers had of course to take more than a passing interest, and many improvements in gear design and production are entirely due to their constant efforts.

The year 1940 marked the beginning of the end of the getting-by process for we were then cut off from foreign supplies of hobs and machines. Today the gear engineer exists in his own right, the world over. The old-time engineer found he was spreading his efforts rather thinly. In this specialist age, gear engineering itself can be subdivided; a man can spend his whole life designing, calculating, measuring, testing or producing gears. He can specialize in spurs and helicals, or bevels, or worm gears, and find plenty to occupy him. But a knowledge of geometry, and gear geometry in particular, is an essential background in all

the ramifications of the subject. The author has spent his working life with Falk Corporation and Gleason Works on gear geometry, contacts, surfaces, the methods and machines for producing those surfaces, and this book is an attempt to sum up and pass on his most important conclusions.

The present work, intended to be the first of a series, is confined to spur gears, a natural starting-point. Helical, bevel, hypoid, and worm gears, which involve three-dimensional geometry, will be treated in future publications. As defined by the author, kinematic geometry concerns moving lines and points, as opposed to the usual conception where everything is static. The coverage includes: general principles; tooth design; cutting and generating spur gears; involute curves and teeth; fillet curves; layout of involute profiles; tooth thickness calculations; centre distance changes; geometric strength factors; profile curves and modifications; and involute approximations.

There is much to interest the general reader, or the beginner. Sooner or later, as he dives deeper into the subject, both the learner and practising engineer will find answers to real practical problems in KGGT. Since hobbing predominates, the usual treatment is confined to rack generation, and Fellows cutting skipped over. In shaping external or internal gears, it is sometimes necessary to calculate the exact root diameter, to clear a shaft or a spigot mounting. It may come as a surprise to many experienced gear men that we have to measure the outside diameter and the tooth thickness of the Fellows cutter at the point in its life when we want to use it. All this is explained. A hob is supposed to retain its shape under repeated sharpening. A Fellows cutter, being in effect a corrected gear, changes its shape and in some circumstances this must be allowed for. The Fellows process is rack generation at second hand.

Buckingham, from 1925 onwards, laid the foundations of involute trigonometry as we know it today, but there is room for difference of opinion on the methods employed to solve recurrent problems. Mr. Candee presents methods claimed to be shorter and more direct than the conventional treatment. Both give the same answers. Some people have a horror of the "involute function" and the alternatives may appeal to them. Buckingham's "inv ϕ" is the angle (in radians) subtended at the centre by an arc of involute between the origin and the point considered; many of the problems, when properly set out, can be resolved by simple addition and subtraction of angles in radians. We are helped to understand the formation of fillet and root curves, a usually neglected part of the work, that can give real trouble in practice through fillet interference, by the author's clear exposition.

The section on involute approximations should be of particular interest to builders of form grinding machines. There have been many attempts to substitute involutes by circular arcs, astroids, etc., which closely conform to the involute curve over the short lengths considered and are easier to produce mechanically. The cardioid or heart-shaped curve is presented as being better than most of those tried so far.

This may be described as an astringent book: there is not an ounce of padding in it. It has a bibliography and an index. Printing, layout and diagrams (drawn by the author) of high standard. For the remarkably few errors in proof reading and printing, seemingly inevitable in a book of this nature, the reader can in most instances himself supply the needed correction. (Exception: α at the top of page 156 should read α^2.)

The historical notes as to who invented what, and when, are of real interest and provide a welcome break when the going gets a bit hard.

A. M. GUNNER

Trade Publications

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Ventilation and Air Compression

Rotary Compressors. CONSOLIDATED PNEUMATIC TOOL CO., LTD., 232 Dawes Road, London SW6. A brochure describing the full range of oil-flooded rotary portable Power Vane compressors. The first section describes operating principles, and design and constructional features. A section follows in which specifications are given of units with capacities from 125 to 600 cu. ft per min. Examples illustrated include truck-mounted compressors. 29 pp., ill.

Diffusers. FAIRITT ENGINEERING CO. LTD., Airmaster Works, Evelyn Road, Sparkhill, Birmingham 11. The first section of this catalogue contains descriptive lists, with dimensioned diagrams, of the various types of diffusers in the Airmaster range. The second section consists of data sheets, giving velocities, output, decibel ratings, and methods of fixing and testing. Factors governing the selection of air diffusers are considered. Loose leaf. 96 pp., ill.

Electronic Air Cleaners. WESTINGHOUSE ELECTRIC INTERNATIONAL COMPANY, 40 Wall Street, New York 5, NY, USA. A booklet (Catalogue 1450) describing the characteristics of electronic air cleaners and how they may be applied to collect oil mists resulting from machine tool operation. 8 pp., ill.

Fans and Grit Arrestors. DAVIDSON AND CO. LTD., Sirocco Works, Belfast 5, Northern Ireland. This booklet describes Sirocco equipment for the iron and steel industry. A representative selection of installations in service is illustrated; these include main sinter fans, grit arrestors, fans for sinter coolers, furnace re-circulating fans, gas boosters, pneumatic conveyors, induced-draught fans, and de-dusting units. Graphs showing performance are included. 12 pp., ill.

Blowers. KEITH BLACKMAN LIMITED, Mill Mead Road, London N17. Two publications dealing with Tornado blowers. Leaflet No. 56 refers to turbo multistage blowers with from two to seven stages in sizes from 18 to 42 in, supplying air up to a pressure of approximately 7½ lb per sq. in or an exhauster suction of up to 5 lb per sq. in. Booklet S7 relates to medium-pressure blowers available from stock. Five sizes may be selected, for volumes of from 20 to 3,000 cu. ft per min, and static presures from 1·0 to 9·0 in wg. 4 pp. and 8 pp. respectively. Both ill.

Gas Mechanics. CENTRAL SCIENTIFIC COMPANY, 1700 West Irving Park Road, Chicago 13, Illinois, USA. A booklet describing kinetic theory apparatus which has been evolved to demonstrate the fundamental principles of gas mechanics. The apparatus uses ⅛ in diameter plastic balls to simulate molecules. 20 pp., ill.

New Books

Industrial Growth and Population Change. By E. A. Wrigley. *Cambridge University Press.* (32*s* 6*d*)

Study of the coalfield areas which stretch from Pas-de-Calais and Nord, through Hainhault and Liège, to Aachen and the Ruhr, covering the period 1850-1914.

Problems in Basic Operations Research Methods for Management. By RANDOLPH W. CABELL and ALMARIN PHILLIPS. *Wiley, New York and London.* (32*s*)

Collection of exercises and problems designed originally for use in the course on operations research methods at the Graduate School of Business Administration, University of Virginia. Mathematical programming, inventory problems, queuing problems, Monte Carlo analysis, sequencing models, replacement problems, assignment problems, and the design of experiments and analysis of variance are investigated. There are no solutions to the problems—the student is on his own.

Computer Analysis of Cylindrical Shells. By J. E. GIBSON. *Spon.* (84*s*)

Design data for 286 representative forms of shell roof are tabulated. The calculations were made on a Ferranti "Mercury" digital computer. The present volume supplements *The Design of Cylindrical Shell Roofs* (see New Books, 30 June 1961, p. 904).

Applied Theory of Gyroscopes. By B. V. BULGAKOV. 2nd Edition. *Published for the National Science Foundation, Washington, by The Israel Program for Scientific Translations, Jerusalem.* (70*s*)

Beginning with a discussion of the fast-rotating symmetrical gyroscope, the author then moves on to the treatment of the gyroscopic pendulum, Foucault gyroscopes, the astatic gyroscope and its applications, gyrocompasses and direct gyroscopic stabilizers. The final chapter is devoted to the exact general theory of gyroscopes. Translated from the 2nd Russian edition (1955).

Heat Transfer. By BENJAMIN GEBHART. *McGraw-Hill, New York and London.* (83*s* 6*d*)

The physical processes, theories and methods of analysis of the three modes of heat transfer are treated fairly comprehensively. Although primarily a post-graduate textbook, the interests of the general reader and practising heat engineer are also catered for.

Introduction to Transients. By D. K. MCCLEERY. *Chapman and Hall.* (42*s*)

A not too rigorous approach to the study of transient electrical phenomena, using the Heaviside operational calculus. The treatment is suitable for electrical and electronic engineering students who are reading for examinations at about degree level.

Audio Frequency Engineering. By E. HAYDN JONES. *Chatto and Windus.* (35*s*)

Writing for persons who are equipped with a sound knowledge of light-current engineering theory and wish to specialize in electro-acoustics, the author has placed the emphasis on fundamental theory rather than on the latest practical achievements.

Magnetrons. By K. HINKEL. *N.V. Philips' Gloeilampenfabrieken, Eindhoven; Cleaver-Hume Press, London.* (22*s* 6*d*)

Well-illustrated and concise introduction for physics and engineering students and technologists to the principles and applications of the magnetron in particular, and microwave engineering in general.

Adaptive Control Processes: A Guided Tour. By RICHARD BELLMAN. *Princeton University Press, Princeton, New Jersey; Oxford University Press, London.* (42*s*)

A unified approach is presented to the formulation of deterministic and stochastic control processes and to their computational solutions. Reader specification: applied mathematicians, mathematical physicists, mathematically inclined control engineers, theoretical psychologists, operations analysts and mathematical economists.

Engineering Laboratory Work. By S. R. OULSNAM and B. G. BROTHERS. Part 2: Materials and Machines. *Cleaver-Hume Press.* (18*s*)

Broadly speaking, the present volume embraces the laboratory work associated with the subject Materials and Machines as studied in Year A1 of the HNC Course in Mechanical Engineering. All the apparatus described is either available commercially or can be made with the minimum of difficulty.

Impact Testing of Materials. By WILHELM SPÄTH. 2nd Edition. *Thames and Hudson.* (25*s*)

In preparing this English version of Dr. Späth's important survey, Mr. Rosner has incorporated much recent work and has recast and expanded those sections of the book that derive basically from British and American standards. The bibliography is fairly comprehensive.

The Reviewers

Dr. I. S. Pearsall is a bachelor of science in mechanical engineering and obtained his Ph.D. for work on the hydraulics of surge tanks. A senior scientific officer at N.E.L., he is at present working on axial flow pump and fan research.

Flt.-Lieut. D. Stinton, A.M.I.Mech.E., A.F.R.Ae.S., is a test pilot at the Royal Aircraft Establishment, Hampshire.

Mr. C. R. Turner, B.Sc., is project leader (communications satellites) with Hawker Siddeley Aviation Limited. He is also an A.F.R.Ae.S.

Mr. A. M. Gunner, A.M.I.Mech.E., Mem.A.S.M.E., is engaged in gearing research and development with Associated Electrical Industries Limited, Rugby. His interest in gears and gearing dates from lectures by the late Edmund Harwood at the Borough Polytechnic in 1925. He has specialized in small and medium gears and the machines and tools for their production, and has served on British Standard gear and spline committees.

Marketing

Optimistic Outlook Maintained at Farnborough

"A most satisfactory occasion." That was how Mr. H. G. Nelson, President of the SOCIETY OF BRITISH AIRCRAFT CONSTRUCTORS, described the 1961 Farnborough Flying Display and Exhibition while speaking at his Press conference on the closing day.

Many had expected that this year's display might not have been as successful, both from the point of view of spectacle and orders received, as it has been in previous years. This prediction was, in many cases, based on the assumption that Britain is now in effect at the end of one era and at the moment unable to present to the world her ideas for the next. Mr. Nelson perhaps substantiated this when he said he had "no reason to doubt that there would be a show in 1962" and went on to suggest that it could well be a vintage year with "up to ten new aircraft" either flying or displayed statically.

Regardless of this, however, many considerations have combined to make the show successful from all standpoints and the President warmly expressed his satisfaction at the results. Britain's export turnover is running at an annual rate of £160 million and there were good prospects that this level would be maintained. Orders announced during the week included five VC10's for the Royal Air Force, bringing the total sold so far to 57, three HANDLEY PAGE HERALDS for export to Italy and Canada and a COMET for King Saud of Saudi Arabia. In addition there was the substantial order for BRISTOL SIDDELEY engines referred to separately on this page.

Ancillary equipment manufacturers exhibiting at the show were well pleased with the attention shown on their stands and in addition to a large number of on-the-spot orders a great many appointments were made to visit potential buyers on their own premises after Farnborough week. Notable amongst the equipment orders were flight recorders for the VC10, and MARCONI doppler navigators for the French Mirage 3's.

As for the future, Mr. Nelson declared that there was scope for international cooperation which, in view of the high cost and extreme complexity involved in the development of new projects would avoid unnecessary duplication, wasteful competition and increase the size of the market and resources available.

Success Story of the Show

One of the happiest men at Farnborough must have been Mr. Peter Masefield, managing director of Beagle. Considering the company did not even exist at the time of last year's display, they had a most successful week and Mr. Masefield stated that firm inquiries gave every indication of sales resulting from the show topping the £1 million mark by a considerable margin.

Included in the group, which is a subsidiary of the Pressed Steel Company, are Auster Aircraft and F. G. Miles, both of whom were marketing designs which have influenced to a greater or lesser degree the configuration of the Beagle products. The smallest in the range, the A61 Terrier which is developed largely from the Auster Mk Six has been particularly successful. This is perhaps not altogether surprising, as costing less than £2,000 in the UK, it would appear to represent remarkable value for money.

At the other end of the scale is the luxury B206 5/7 seater which, while at £30,000, beyond the means of the majority of club and private fliers, should prove admirably suited to the needs of the ever increasing number of firms showing interest in this means of executive travel.

EMI to Exhibit in Czechoslovakia

The Brno International Trade Fair being held in Czechoslavakia from 10 to 24 September includes a comprehensive range of EMI equipment, the centrepiece of which will be a scale model of the EMIDEC 1100 computer. For reasons of space a full size installation is impracticable but the model, showing integral units of the system including the computing centre, control desk, magnetic tape units, punched card reader, card punch, paper tape reader, paper tape punch printer unit and power supply unit illustrates how the computer provides a data processing installation capable of dealing with, it is said, the most complex problems of modern commerce and industry.

Also on show is a working demonstration of the EMI Image Orthicon Camera Channel Type 203/6 operated entirely by remote control. An accessory to this will be a shot selection box which enables a series of pre-selected shots to be put into sequence simply by pressing buttons.

Two tape recorders are also exhibited, both of the portable type, which is rapidly gaining in popularity: the models shown are the stereophonic TR52/2 and the RE321. The latter, being light and easily operated, has a wide range of applications and is suitable for data recording, research, and on-the-spot recording.

The display is completed by a range of smaller ancillary equipment including electronic valves and instruments, one of which is the commutator undercutter Type 1A used for shaping the mica on commutator armatures.

Animal Feed Plant for Hungary

Two British firms: W. S. BARRON AND SON Limited, milling and electrical engineers of Bristol Road, Gloucester, and CONDOR ENGINEERING Company Limited, structural engineers of Winchester, Hampshire, have been awarded a contract to supply a centrally controlled animal feeding plant to Hungary. The contract covers the supply of steelworks, silos, electronic control panels, process machinery and mechanical handling equipment. When completed the plant will be unique in Hungary and certain features, such as the specially designed fully prefabricated smooth faced steel silos will be, it is claimed, the first of their kind in the world.

The value of the contract is £200,000 of which Condor Engineering's share, as sub-contractors to W. S. Barron, is £50,000 covering the supply of the blending and grinding silos and the structure to house the milling machinery and provide storage facilities.

The plant is to be located near Szentes which will become the focal point for processing grain from all over Hungary where a collective system is in operation under state supervision. The storage block has a capacity of 1,000 tons and a conveyor system transports the grain through the various stages of processing, which are carried on simultaneously; provision is made for automatic blending of meal or grain to fixed weight formulas. All the processes are controlled centrally by panels of electronic micro-switches specially designed for Szentes by W. S. Barron Limited. Erection of the prefabricated sections comprising the plant will be by local Hungarian labour under supervision of Condor and W. S. Barron personnel.

Making it Easier for the Housewife

RICHARD COSTAIN (CONSTRUCTION) LIMITED have been awarded a £186,000 contract to carry out preliminary work on a £1,300,000 scheme to provide the centre of Middlesbrough with a pedestrian shopping precinct. The work is to be carried out for the METROPOLITAN RAILWAYS SURPLUS LANDS COMPANY LIMITED who have employed CARTWRIGHT WOLLANTT AND PARTNERS to do the designs for the project. Included in it will be 39 shops, an underground car park and a seven-storey office block bridging the paved area.

The Costain contract provides for the excavation of the site, the sinking of 48 in diameter bored piles, construction of basement foundations and the erection of structural steelwork. This initial stage of the work is scheduled for completion during March 1962.

Large Order for Viper Turbojets

De Havilland Aircraft Limited have placed a £1 million order with Bristol Siddeley Engines Limited for 60 of the new Viper 20 turbojets. They will be used in de Havilland's executive aircraft, the six-seater DH 125.

The Viper 20 has been developed from the Viper II and design improvements have resulted in an increase in static thrust from 2,500 to 3,000 lb. Contrary to conventional practice when a step-up in performance is accompanied by an increase in fuel consumption, the Viper 20 burns 0·985 lb/hr/lb compared with 1·07 lb/hr/lb for the previous unit; this is an important consideration for an engine destined for use in an aircraft, the running costs of which will be borne largely by a private concern. Another executive aircraft for which the engine has been chosen is the Piaggo Douglas PD 808.

Vipers are also proving popular in other fields, especially trainer aircraft, where large numbers are in service with the Hunting Jet Provosts of the RAF and Royal Ceylon Air Force and the Macchi 326, the standard jet trainer of the Italian Air Force. The Australian Jindivick target drone is also powered by a similar unit.

Metal Machinery Export Orders

During recent weeks, the BRONX ENGINEERING Company Limited of Lye, near Stourbridge have received substantial orders from overseas for their tube and sheet metal machinery. The total value exceeds £90,000, the most important being a £45,000 order from Stankoimport, Russia, for plate bending rolls. Also from the Eastern Block comes a £14,000 order for the supply of tube straightening machinery to Czechoslovakia, whilst similar plant to the value of £24,000 is being sent to Finland and to Switzerland in a £7,000 contract.

Disused Railway in A1 Improvement

Continuing the gradual conversion of the Great North Road (A1) into a highway capable of providing rapid north-south transport for a heavy volume of traffic, a length of abandoned railway track is to be adapted as a part of a scheme in Huntingdonshire. This latest section of the modernization plan includes a "flyunder" junction and will improve a further 1½ miles of the road.

The agents are the Huntingdon County Council, who have placed a contract worth £391,182 with A. MONK and Company Limited to carry out the work, which will link earlier improvements south and north of the village of Buckden. The existing road winds through the village and a particularly difficult point occurs at the junction with the Huntingdon Road (A.141). The new scheme is to construct a short by-pass west of Buckden High Street and running roughly parallel with it. It will have dual 24 ft carriageways with a wide central reservation and a roundabout at the southern end. It will be traversed by two pedestrian subways.

Traffic travelling from the south to Huntingdon will turn off the trunk road on to a 22 ft carriageway to be constructed on the disused railway line passing beneath the A1 to join the A141 at the site of the old station bridge which is to be demolished. The existing length of the road between this new junction and the trunk road will be used mainly for vehicles arriving from the Huntingdon direction and intending to travel south but, for practical considerations it is not intended to introduce a one-way system.

The scheme has been prepared by the Huntingdonshire County Council under the supervision of the County Surveyor, Mr. R. E. C. Dorling, and is scheduled for completion during the autumn of 1962.

In a note headed "the Watches of Switzerland" (ENGNG., 1 Sept. '61, p. 285) the total earnings of the watch industry were quoted. We regret that we were misinformed in these figures, and the total for 1960 was 1,259,248,341 Sw. Frs. (not 12,592,000 Sw. Frs. as stated). The figure for 1959 was 1,124,569,909 Sw. Frs. (not 11,246,000 Sw. Frs.).

The Massey-Ferguson 780 Combine Harvester

The story of a vigorous Canadian company; the first to bring the agricultural engineer's ultimate goal, a self-propelled combine harvester, into practical reality.

Fig. 1 The 780 as it leaves the factory.

TO ANYONE unfamiliar with it, the general appearance of a self-propelled combine harvester completely belies its usefulness. Divorced from its true element, the harvest field, it looks a really clumsy contraption—a framework of flimsy steel bars and angles and a hotch-potch of belts, chains, wheels and cranks thinly disguised by light sheeting. The combine gives no hint of the mass of technical problems that had to be solved before it became feasible.

To be a success in any country, the self-propelled combine must satisfy six conditions:

(1) It is expected to reap the crop and also thresh and clean it efficiently with the minimum of grain loss, while actually travelling.
(2) It must accommodate crops of varying moisture content under a wide range of temperature and humidity conditions.
(3) It must be light enough to traverse soft ground; yet the driving wheels must provide sufficient tractive power to keep it moving.
(4) It must be utterly dependable for a few successive weeks during the harvest season, while remaining practically idle for the rest of the year.
(5) It must be immune from damage due to picking up large stones or other objects.
(6) It must sell at an acceptable price.

The big advantages of using a combine over other methods of harvesting are its speed and the saving in manpower. With the Massey-Ferguson 780 it is common for two men to cover 15 to 20 acres in a single day's work leaving the grain threshed, cleaned and bagged: ten times the area they would cover using scythes and old-fashioned methods, leaving threshing and cleaning still to be done. Speed of action is particularly important with a fickle climate like ours, where the farmer has to take the maximum advantage of good harvesting conditions while they last; though the 780 has an enviable reputation for saving a crop after it has been flattened by rain.

The Massey-Ferguson group of companies, with the parent company in Toronto, stems from a union between Massey-Harris, makers of harvesting equipment, and Harry Ferguson on the tractor side, which took place in 1953. It was the final stage in the evolution of a world-wide organization which now covers the entire field of agricultural machinery and has the biggest total turnover of such equipment in the world.

The Massey-Harris side of the business goes back to 1847 when Daniel Massey established a small workshop on the shores of Lake Ontario for the manufacture and repair of farm machinery. A merger in 1891 with a rival Canadian firm, originally founded in 1857 by Alanson Harris, was followed by a steady expansion and the establishment of several subsidiaries overseas, including Britain. With a long record of pioneering in harvesting machinery of various kinds, it was no surprise when Massey-Harris started on the final development, the self-propelled combine. This step was taken in 1936 and three years later emerged the No. 20 Reaper-Thresher, the first self-propelled combine in the world—a big awkward machine by present-day standards but having a tremendous potential usefulness.

MECHANIZATION

The beginning of the industrial revolution in Britain was the time when, by invention and re-invention, the idea of mechanizing agriculture first began to be pursued seriously. Yet, until then, farmers all over the world were using substantially the same primtive tools of agriculture as those used by the ancient Egyptians.

Threshing, for instance, was done by flailing and winnowing. In flailing, the crop heads were beaten on a stone floor until the grain became separated and could be swept up. Winnowing consisted of placing the grain in a large sieve and shaking it to release the rest of the chaff, assisted by a strong breeze through the barn.

In 1732 a Scotsman invented a device reproducing the flailing action. Later improvements included the rotary cylinder, and then an early grain separator; a machine which used beating cylinders to thresh and "straw walkers" to clean the grain. About 1860 came the familiar threshing drum or box, whose threshing performance in terms of low grain loss has yet to be equalled by the combine. The saving in grain loss with the combine lies in the elimination of handling.

Meanwhile, in 1783 the Royal Society of Arts offered a prize to anyone who could devise a practical reaping machine. One competitor employed the cutting principle now universally used today; the horizontal cutter bar with two sets of saw-toothed knives moving back and forth one above the other. Projecting fingers in front of the knives held the stems while being cut. Later came the rotating "reel" mounted on a horizontal axis in front to sweep the grain against the cutting apparatus and then on to the delivery table. Finally in 1827 came Patrick Bell's reaper, shown in Fig. 2. It had an endless conveyor belt to discharge the cut grain at one side of the machine.

Further developments in harvesting machinery then switched to the other side of the Atlantic. There was still a big gap in the mechanization sequence, the job of binding the reaped crop into sheaves for conveyance to the threshing barn or storage place. Until this back-breaking operation could be done mechanically or dispensed with, the speed of harvesting must still depend largely on available manpower. Strangely, the latter alternative as offered by the combine does not seem to have occurred to anyone for a number of years, for development of the mechanical binder received a great deal of attention. It was pursued by both the Massey and Harris companies in Canada prior to the 1891 merger, and indeed for a time it was their most important product.

The trailed combine was first introduced by M-H in Canada about 1910. It was offset so that the mules towing it did not tread down the crop to be harvested. It greatly reduced the total manpower requirement by enabling two men to reap, thresh and clean from 12 to 15 acres per day, but possessed three big disadvantages. The mechanism was driven by the rotation of one of the carrying wheels, and the constant cylinder speed, so important to good threshing was practically unattainable. Furthermore, a considerable towing effort was needed to move the machine and also provide the drive. Lastly, a wide track had to be cleared around the field to provide a path for the mules before the

Fig. 2 (below) The Bell reaper of 1827, now in the Science Museum.

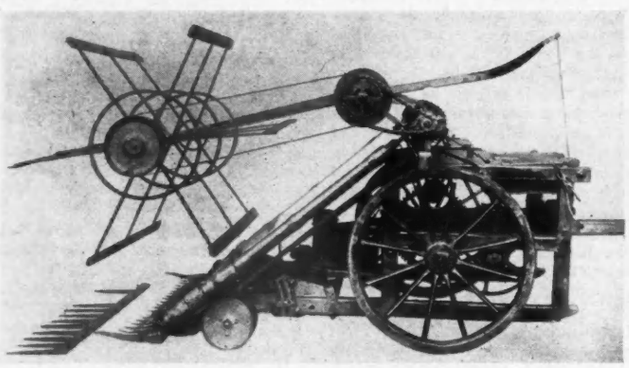
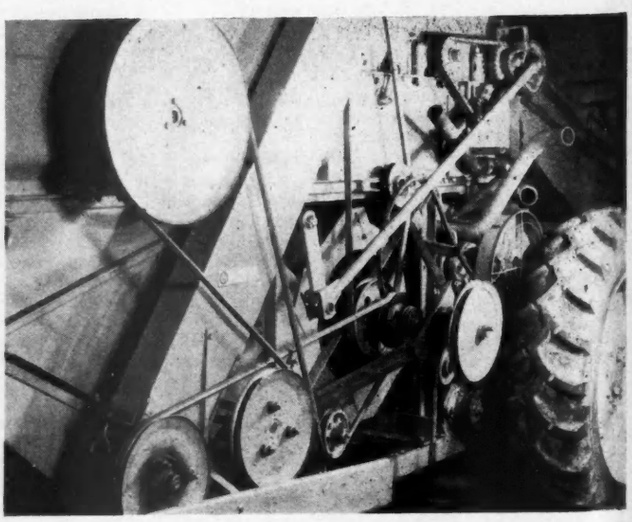


Fig. 3 (right) Power drives of the 780.



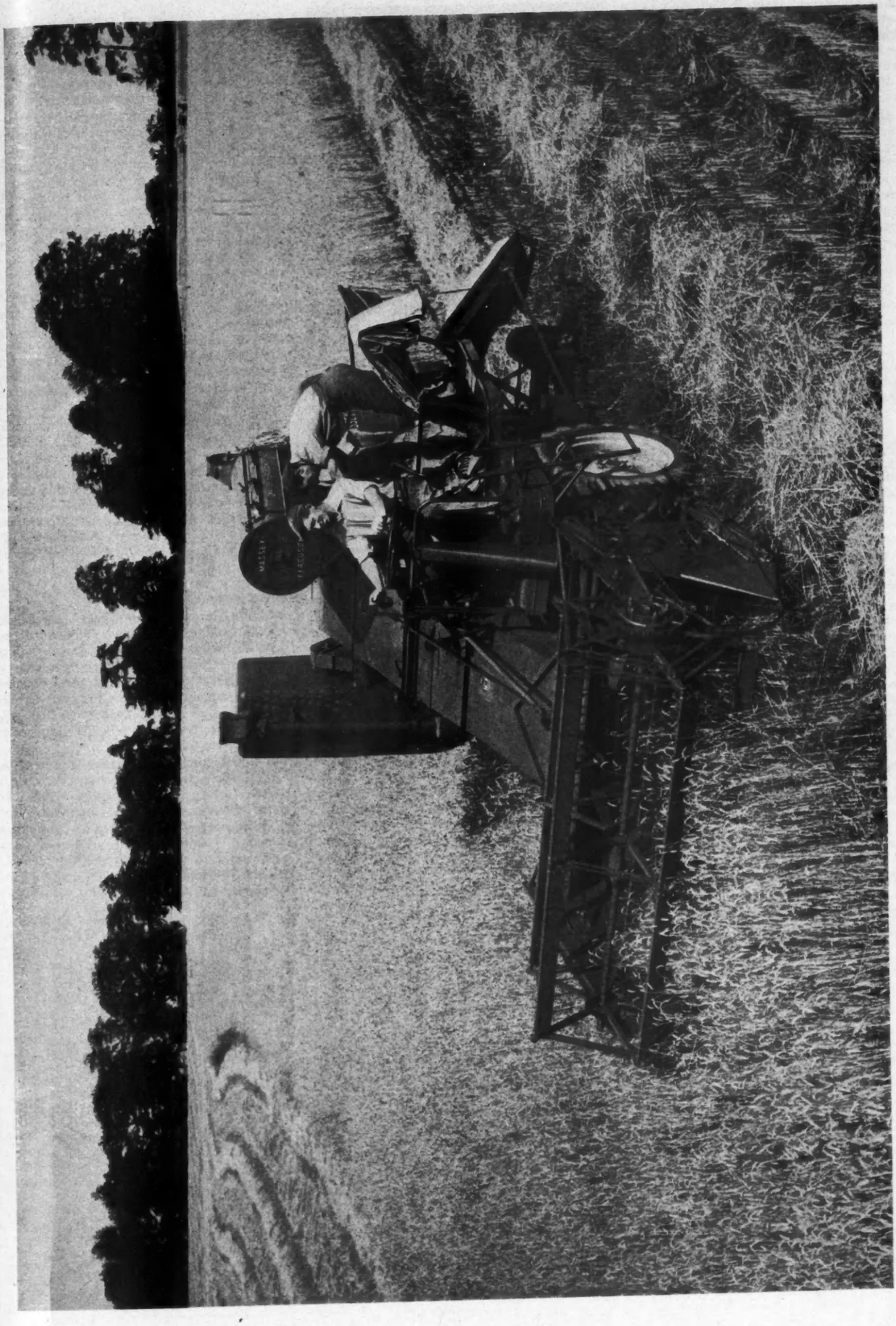


Fig. 4 A machine intended for one particular set of working conditions can be made ideally suitable.

combine could start. Nevertheless, the coming of tractor power in the 1920's gave the trailed combine a surprisingly long innings, aided by fitting an engine to drive the threshing mechanism.

Massey-Harris were dogged for years by the difficulty of breaking into the North American market. The onset of war in 1939, coupled with the timely advent of the No. 20, enabled them to make good this deficiency in a most daring and spectacular manner. They formed a squad of men and 500 machines into a " harvest brigade " which set out in 1944 to tour the North American continent in order to both prove and demonstrate the self-propelled machine's capabilities. The brigade also contributed towards gathering a record harvest at a crucial stage of the war when Britain desperately needed wheat. This operation was so successful that for some time the ensuing flood of orders from American farmers for combines and other M-H products was an embarrassment to the company.

SCOTTISH FACTORY

With a subsidiary selling company well established in Britain, factory premises were obtained at Trafford Park, Manchester, in 1945 for assembling Massey-Harris products from parts produced in Canada. In 1949 full production of combines started at a new factory at Kilmarnock, in Scotland, to satisfy the demands of sterling area countries. British-built machines embody certain minor differences from those built in Canada, to suit the European market. A steady trend towards increased capacity led first to the 726, and in 1953 to the 780, which with grain output of roughly 3 tons per hour, quickly gained an excellent reputation.

The basic operating principles established by Massey-Harris are common to all combines. As with any kind of threshing tackle, satisfactory performance depends on both the skill of the operator and the condition of the crop. An even feed rate maintained by the cutting and conveying section at the front of the combine is particularly important.

In the 780, the reel position can be adjusted both horizontally and vertically during work. The table, which carries the reel, cutter bar and an auger for feeding the conveyor, is raised or lowered hydraulically to suit the height of the crop and ground undulations. The operator's offset position enables him to see the whole length of the cutter bar without chaff being thrown into his face. The cut crop is carried up the conveyor to a beater which shreds the crop and assists in feeding it to the cylinder.

The cylinder is of the open type and carries rasp bars which rub the grain kernels out of the

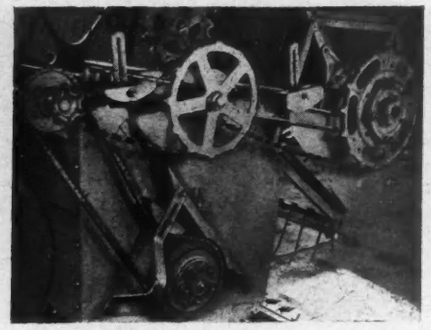


Fig. 5 Reel and auger drives.

head against a stationary grid beneath called the " concave." Here most of the threshing is done, and correct concave adjustment and cylinder speed are vital. The grain and chaff then fall on to an agitated grain pan and an adjustable chaffer sieve. A blast of wind carries most of the chaff and the straw out via the straw walkers at the rear of the machine. A lower sieve completes chaff separation and collects any unthreshed heads, whence they are fed via a returns auger and elevator to the cylinder for re-threshing. The threshed grain is directed via the grain auger and elevator to the rotary separator and thence to the bagging section of the machine to the right of the operator. Alternatively the machine can have a grain tank.

Disposal of the straw from the threshing cylinder is so arranged that any grain carried with it is separated and returned to the grain pan. A beater forces it on to the straw walkers, sloping serrated chutes carried on cranks giving an agitating motion to ensure separation of any grain particles. The cranks, incidentally, have oil-impregnated wooden bearings which are also used on other parts of the machine, having been found to give excellent service.

The heaviest portion is the engine, usually a Perkins 56 hp 4-cylinder diesel almost directly over the traction wheels. Low disposition of the engine is sometimes criticized on the grounds of inaccessibility, but M-F maintain that a low centre of gravity is of greater relative importance. Drive to the various motions is generally by belt, but chains and sprockets with slipping safety clutches are provided at all essential points.

The speed of the threshing cylinder is kept constant at a speed best suited to the particular crop, and may be anywhere between 300 and 1,200 rpm. A mechanical governor on the engine keeps the speed within a 2 to 4 per cent surge range. To give a wide choice of travelling speeds an ingenious belt-operated speed variator is coupled to the engine output with hydraulic setting under the control of the driver.

Apart from minor improvements from time to time the 780 combine today is basically the same as the first 780's. The remarkable longevity of the machine may be accredited to two factors—the inherent rightness of the original design and the lack of competition. For it is only in the last four years that other manufacturers have caught up and started to sell combines in any volume. Even so, eight out of every ten self-propelled combines used in this country are of Massey-Ferguson manufacture.

Combine and baler production is now concentrated at Kilmarnock, the company having turned out well over 33,000 combines since 1946, over half of them 780's. Though the name Massey-Harris was applied to combines for a few years after the Ferguson merger, which gave rise to certain confusion, all products now bear the name Massey-Ferguson.

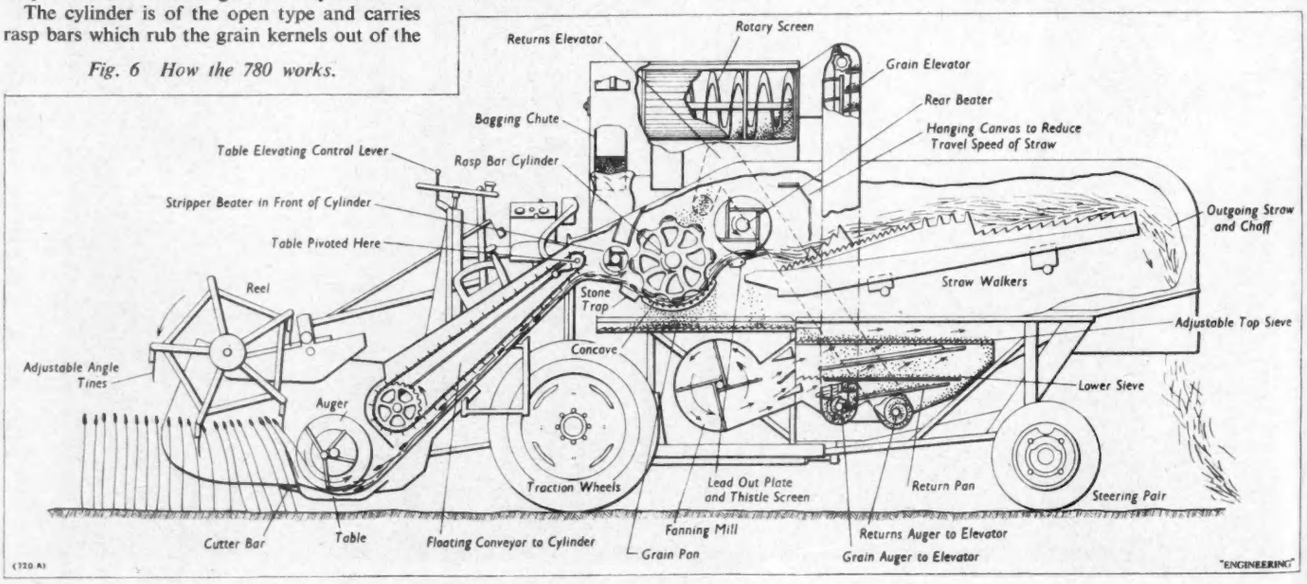
It goes without saying that the organization selling in over 140 countries offers first class spares and service facilities through a comprehensive distributor/dealer network. Cost is an all-important consideration, even with a machine like a combine which may well pay for itself in a few weeks of intensive operation. Most farmers with upwards of 100 acres under cultivation already own a combine, and nearly every new one in this country is sold in part exchange. At £1,850 the 780 cannot be beaten on a sheer value-for-money basis.

Massey-Harris employ great thoroughness when developing new products. Not only do they maintain design staff in many corners of the world, directly responsible to the parent company, to study local conditions; but new prototypes are given exhaustive field trials in every territory in which they might conceivably be used. Prototype testing is particularly important with the sensitive combine.

It is no secret that prototypes of a new Massey-Ferguson combine have been on trial all over Europe during the past three years. No doubt it will reflect the continuing trend towards increased capacity and greater operational refinement; but the company are known to have no intention of withdrawing the faithful 780.

Massey-Ferguson (United Kingdom) Limited, Banner Lane, Coventry.

Fig. 6 How the 780 works.



Hydrostatic Extrusion at Low Pressure

A new method of extrusion, developed by the DSIR's National Engineering Laboratory, East Kilbride, Glasgow, gives products with more uniform mechanical properties and requires much lower pressures than conventional processes.

Extrusion pressure is applied hydrostatically without any direct contact between ram and billet. Tests of the process have so far been restricted to pure aluminium and an aluminium alloy, but the Laboratory is taking the work a stage further by investigating the cold extrusion of other metals, especially steels.

In the new process, a cone is machined at one end of the billet so that it fits closely into a die with a conical entry. The die forms the exit from a cylindrical high-pressure chamber containing a liquid, such as glycerine, castor oil, or a dispersion of molybdenum disulphide in oil. The other end of the chamber is closed by the ram of a hydraulic press. As the ram moves into the chamber, pressure builds up in the liquid, which then transmits the extrusion pressure to the billet. The material is extruded through the die without any direct contact between ram and billet. The fluid acts as an efficient lubricant and makes it possible to use conical re-entry dies with very small die angles.

In addition, the nosing of the billet reduces the amount of work expended in deforming the metal and, hence, the amount of extrusion pressure required. Reductions in extrusion pressure of 30 to 40 per cent have been obtained in laboratory tests. With pure aluminium, the maximum extrusion pressure for the production of rod at an extrusion ratio of seven, through a conical re-entry die with a 20° included angle, was 17 tons per sq. in. This compares favourably with a pressure of 32 tons per sq. in which is required for a conventional extrusion through a square entry die. With an alloy (0·7 per cent magnesium, 1 per cent silicon and 0·7 per cent manganese) the pressure was 29 tons per sq. in, compared with 43 tons per sq. in by conventional methods.

All these figures are for extrusion of an unheated billet. The distribution of hardness over the cross-section of the extruded rod was much more uniform than usual—a factor which will often have useful advantages. The results suggest that cold extrusion of high-strength materials will be possible.

Differential Pressure Flow Recorder

A recorder for continuous measurement of gas or liquid flow, which may be of particular interest where noxious gases or corrosive liquids are involved, has been developed by Associated Electrical Industries' Instrumentation Division, Harlow, Essex.

Designated the Model 202, the new recorder incorporates the AEI/Barton differential pressure unit, which in this case employs a stainless steel bellows and forged carbon steel, or forged stainless steel, housing. The recorder offers the possibility of significant saving in maintenance costs, because, unlike a sealed mercury meter which requires frequent cleaning, the Model 202 may be left without attention for long periods.

It may also be used with corrosive oil without seals, because there is no mercury to emulsify with the oil. Full line pressure may be imposed across the bellows mechanism indefinitely without damage to the meter; making the new model particularly useful where overloads are frequently encountered.

The recorder is compact in construction, with the chart mechanism housed in a rectangular, fully weatherproof, die-cast aluminium case which protects all working parts from moisture, fumes and dust. It is simple to install, since precise levelling is not necessary, and can be employed in a permanent installation or as a portable test meter.

The chart drive can be electrically or spring operated, and standard charts can be supplied to record over periods of one hour, twelve hours, twenty four hours and seven days. Other charts are available to order, and a lever gear change can be fitted. Twelve-inch charts, free from eccentric or elliptical error, are used.

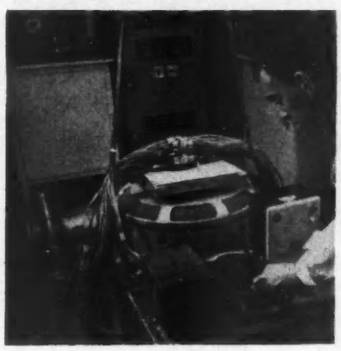
A differential pen is normally fitted, but a static pressure pen, actuated by a stainless steel pressure helix with static pressure ranges up to 10,000 lb per sq. in is also available.

Electrical Components for Satellite Systems

Three broad methods of approach—miniaturization, microminiaturization, and acceleration resistance—are currently being employed at the development laboratories of the Plessey Company Limited in order to develop components suitable for use in space vehicles.

The techniques being investigated in connection with miniaturization and microminiaturization are: the component substrate system; the deposited circuit technique; and solid-state circuitry. In the first method, a range of components is produced in a flat form, having standard breadth and width and differing only in thickness. The separate elements are then stacked and interconnected so that a packing density of up to 250,000 components per cu. ft can be obtained.

In the deposited circuit technique, components are formed by chemical deposition, or evaporation. Solid circuitry is the technique by means



Specially designed equipment is used to test components under conditions of high acceleration.

of which a complete circuit is produced by changing the homogeneity of a piece of material, usually silicon, so that individual components are formed with desired electrical characteristics. Packing densities up to several million components per cu. ft are anticipated with this technique.

At the recent SBAC Farnborough Air Show, the Plessey Company exhibited some of their work on *g*-resistant components. These included potted matrix units for aircraft computer systems and sub-miniature skeleton potentiometers for guided missile applications.

One of the most important items currently being developed at the company's Caswell Research Laboratories is the silicon solar cell. These silicon photovoltaic devices have so far been developed to give a conversion efficiency of 12½ per cent, under ideal load conditions.

In addition to providing power for space satellites, these devices may also be used to detect the impact of micrometeorites when a vehicle is in orbit. Sunlight passing through the holes made in a thin metallic film by the micrometeorites will fall on the solar cells and give an accurate indication of the size and number of the holes. It is anticipated that this device will be sufficiently sensitive to detect holes made by particles of one millionth of an inch in diameter.

Parallel with the development of specific components, Plessey research engineers are carrying out a continuous programme to test and improve the performance and reliability of various types of communication equipment which are already in use. This work includes testing components and coupling devices under conditions of high acceleration, such as would be encountered during the launching of a satellite (see illustration).

De-icing Technique for Radomes

An aircraft radome construction, which incorporates a system for preventing the formation of ice on the outer surface, has been developed by Marston Excelsior Limited, a subsidiary of Imperial Chemical Industries Limited.

Anti-icing is achieved by ducting hot air through a system of channels between the inner and outer reinforced glass-fibre skins. The channels, which are of triangular shape, are formed in the expanded rubber core and are lined with a thin glass-cloth laminate to provide additional strength.

A special pattern has been evolved which permits the use of channels of constant cross-section, a factor which is important for achieving adequate mechanical strength over the entire surface of the radome.

Before adopting the present, patented construction, consideration was given to other means of providing a heated surface. The incorporation of electrical elements or grids in the structure was discarded for reasons of electrical performance. The use of a liquid heating medium had attractions from a heat transfer point of view, but was not adopted due to the difficulty of finding a liquid both chemically inert and with a similar dielectric constant to the radome structure.

It is thought that the type of construction which was finally adopted, i.e., with a system of channels between the skins, could also be used for cooling radomes which are subjected to a high kinetic heating.

Plastic Moderated Research Reactor

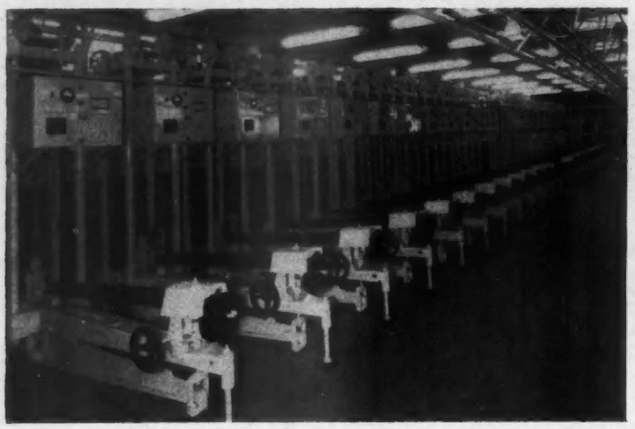
Initial criticality has just been reached in a plastic-moderated low-power reactor which was designed and built at the Battelle Memorial Institute, Ohio, USA. The unit is being operated by the Columbus research centre under contract with the Pratt and Whitney Aircraft Company.

The reactor, designated the Battelle Plastic Reactor Facility, is constructed in the form of a cube and is composed of strips of aluminium and uranium sandwiched with plastic and encased in aluminium boxes. The central portion of the reactor is a void region in which experiments are placed.

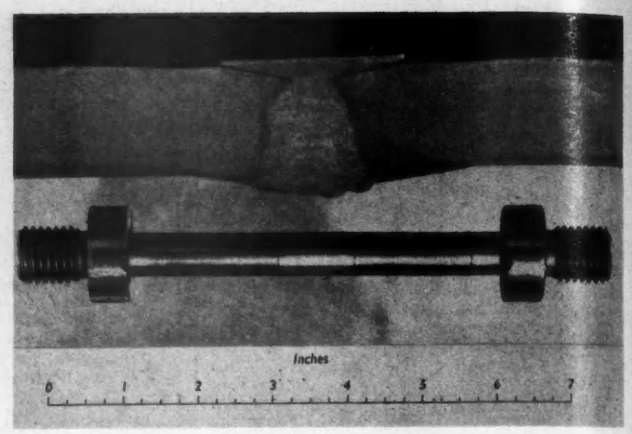
Radiation generated by the reactor is being used in the study of a process in which the kinetic energy (energy of motion) of the fragments resulting from fission of uranium is converted directly into electricity. Fission fragments leaving a thin layer of uranium are positively charged and are endowed with about 84 per cent of the total energy released in the fission event. These fission fragments are collected on a properly insulated electrode, causing build-up of very high voltages (up to several million volts). Subsequent charged fragments do work against this field, thus their energy is transformed from kinetic to electrical energy. Special cells containing thin layers of uranium and appropriate insulation are being inserted into the Plastic-Reactor Facility and their electrical characteristics studied.

The plastic reactor operates at power levels up to 200 watts to provide neutrons to the direct conversion cells placed in the void in the centre of the reactor. One portion of the core is on a movable table, while the other part is on a fixed table. Separation of the core halves during shutdown provides convenient access to the cells. The new reactor is located at the Institute's Critical Assembly Laboratory, which has been in operation for about five years.

XUM



Part of the creep-testing laboratory.



Section of welded pipe joint and creep specimen cut from it.

Steam Pipework for High Temperatures

By J. S. Blair, D.Sc.

During the past thirty years, the working temperatures of electrical power stations have increased by one and a half times, and further increases are envisaged. This, together with rising pressures, necessitates continued research on steels and pipemaking techniques.

It might be thought that with the advent of nuclear power the need for steam power stations would diminish, but in fact this is not so and, indeed, to some extent the competition of nuclear power is making the designers of conventional steam power stations strive for even higher efficiency, which means steam at higher temperatures. In consequence, working temperatures have been steadily increasing over a number of years and now 1,300° F (704° C) is contemplated. While raising the temperature is the more important factor in obtaining fuel economy, higher pressures naturally go with these higher temperatures and pressures of the order of 4,000 to 5,000 lb per sq. in are already in use in supercritical plant and still higher pressures may be necessary.

Apart, however, from conventional steam power stations, nuclear power plants also need high temperature pipework. Nuclear techniques have now reached the stage where higher temperatures are advantageous both in the reactor and in the heat exchangers. A further complication is that the material required for these temperatures may also have to be resistant to the effects of radiation.

While this striving for greater thermal efficiency is very laudable, it must not be forgotten that it brings with it greatly increased cost of boilers, pipework and turbines and, unless special care is taken in the choice of materials and in the method of operating the station, there may be more shut-downs or longer maintenance periods than with the well-established lower temperature equipment.

Need for Research

There is need, therefore, for research into new steels and other materials to withstand these high temperatures. Moreover, a more accurate knowledge is required of the behaviour of pipework under stress and of the stresses which can be withstood, so as to lead to the more economical use of material.

The field of research to be covered is very wide, since not only must steelmaking problems be studied, but also those of pipemaking, manipulation and welding, all of which may be seriously influenced by the choice of the appropriate steel. Design aspects must also be considered and often a good deal of committee work and standardisation is required before a specification for a new high temperature material can be accepted.

Stewarts and Lloyds, who are engaged in the whole of pipemaking from ore to finished product, are well-equipped to cover this wide field and they have a large research department at Corby, Northamptonshire, with branches in the Glasgow and Birmingham areas, which co-operates with the design and production departments concerned.

Naturally, research on high temperature steels is not the only activity of the Research Department; it also covers such matters as corrosion, structural design, instrumentation, examination of new processes and development of special steels, and the general improvement of their products.

Creep Properties

To return to the requirements of high temperature pipework, the most important matter to determine is the type of steel required. When working temperatures were comparatively low, carbon steel, which has so many excellent properties, was adequate for steam pipework. It was soon found, however, that with temperatures above about 850° F the steel stretched extremely slowly under load and might eventually fail if the time were long enough. This phenomenon, creep, has of course been studied for over fifty years, but is still inadequately understood. With higher temperatures, something more creep-resistant than carbon steel is needed and various low-alloy steels have been developed. For the highest temperatures, however, austenitic steels are proposed, and more recently, other special alloys of a complicated type, known as "super-alloys."

Special creep-testing apparatus in which the material is subjected to constant load and high temperature for very long periods has been devised, and Stewarts and Lloyds' Research Department has a large laboratory capable of testing 350 creep specimens simultaneously, some in high sensitivity machines and others in creep-rupture machines. As far as pipework is concerned, the creep rupture characteristic is probably more important than the rate at which the material elongates. In other words, the best steel is one which will last longest at the temperatures and stresses involved, without actual failure, despite any elongation that may take place during its life. In consequence, more attention is now being paid to creep-rupture tests, using machines capable of taking several specimens at once. Previously the emphasis was on the continuous measurement of elongation in high sensitivity machines, and such machines are still required for special investigations, particularly where creep of welds is concerned.

A major difficulty with regard to creep-testing is the long time which it takes and the costly apparatus required to make even a few tests. To determine accurately the creep behaviour of a particular steel may well take four or five years, and it is evident that for design purposes one cannot possibly wait as long as this. A degree of intelligent extrapolation, therefore, must be made from shorter tests, perhaps of about one year's duration. Nevertheless, it is usual to continue the tests for a much longer time even though an interim decision may have to be made as to the likely results. Thus a power station actually in service can have creep specimens of the steel in use being tested under the same temperature and stress conditions but always a year or two ahead of the current life of the station itself.

Recently, the lack of creep data in this country has been recognized by several associations concerned with high temperature properties, and various cooperative research projects have been started—for example, by the Electrical Research Association, the British Iron and Steel Research Association and the National Engineering Laboratory of the Department of Scientific and Industrial Research. Most British steelmakers, under the auspices of BISRA, have formed the British Steelmakers' Creep Committee, the firms concerned undertaking to do cooperative creep-testing and to pool information on a wide variety of steels so as to obtain a wide

Research Report

on work of the

Department of Research and Technical Development, Stewarts and Lloyds Limited, Corby, Northants.

Managing Director (Research)
E. G. SAUNDERS, M.A.

Assistant Director
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range of design data on stress relationships.

While for this type of service creep considerations are the most important, other factors also require research, such as resistance to scaling at high temperatures, the effects of radiation if nuclear work is involved, and all the ordinary tensile and impact properties of the material both at elevated and at room temperatures.

Once the steel has been decided upon, the best method of making the steel must be considered. The method of making the pipe has also to be agreed upon, and here hot fatigue tests and forgeability tests are of assistance, and there may well be special problems of heat treatment, manipulation and fabrication. Much of such research is done by special teams in the works concerned.

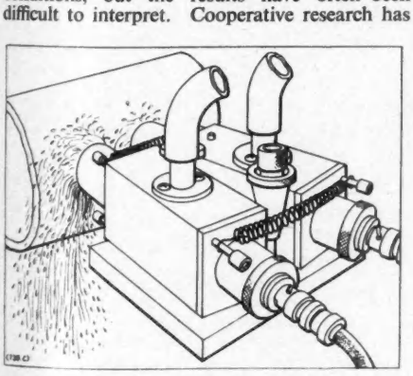
It must be remembered that modern steam pipework is nearly always connected together by welded joints. It is therefore not much use to know the high temperature properties of the parent metal only; those of the weld must also be known and should preferably be not too different from those of the pipe. Stewarts and Lloyds have therefore made many creep tests on composite specimens consisting of longitudinal segments with the weld in the middle. A special technique has been developed to study the relative ductility of different parts of such a specimen. Small triangular ridges round the specimens are left at suitable spacings so as to define the edges of the weld, etc. By measuring optically the distances between these ridges, the elongation of the parent metal, the heat-affected zone or the weld itself can all be separately determined.

Such an investigation of weld properties necessarily involves the examination of a large number of different welding electrodes and techniques to produce the required strength of weld. The special materials now required for high temperature work cause difficulties where welding is concerned. Shrinkage cracking, hard spots and metallurgical discontinuities must be guarded against, and often special heat treatment has to be applied, both before and after welding, particularly in the case of the super-alloys, which as well as chromium, nickel and molybdenum, contain cobalt, vanadium, tungsten, boron, titanium, niobium, aluminium, etc. Because of the special metallurgical condition of some of these materials, hot or cold manipulation may affect the final properties, again requiring some form of heat treatment, which often presents special difficulties in the case of complicated bent pipework.

High Temperature Bursting Tests

It may seem strange that, even to-day, there is no agreement as to the mechanism of creep failure in a pipe under internal pressure, nor as to the formula to be used to determine the effective stress in such a pipe. This is largely because the conditions are not static; slow, steady, plastic flow taking place during the life of the pipe.

Many attempts have been made to relate the results of tensile creep tests with bursting tests of pipe under high temperature and pressure conditions, but the results have often been difficult to interpret. Cooperative research has been undertaken with specimens designed specifically to enable this relationship to be determined, and a number of bursting tests have now been made with carbon steel, low-alloy steel and austenitic steel pipes. It is hoped shortly that the results of this work particularly when taken in conjunction with similar work done in other countries, may lead to an agreed basis for determination of the stress and life of pipes creeping under internal pressure conditions.



Jet probe arrangements for ultrasonic examination of tubes.

Weld Strength

It has long been realized that a weld joining pipe to pipe may not need to be as strong as the pipe material itself. This is because the longitudinal stresses in a pipe are generally less than the circumferential ones and a weld in the circumferential direction, even if made of weaker material than the pipe, is so supported by the parent metal that it will not fail prematurely. What is not so clearly understood, however, is how much less weld strength can be tolerated without effectively weakening the pipework. Various percentage strengths have from time to time been advocated as permissible minima, e.g. 50 per cent, and more recently 75 per cent, but more tests are required to settle this matter. Although some such tests have been carried out and more are in hand, the results so far have been obtained from examples in which the welds joining the pipes have proved to be stronger than the pipe itself. Under these conditions, since failure occurs away from the weld, no indication is given as to whether the weld could not have been a great deal weaker. A series of cooperative research tests are therefore under consideration, using welds of known strength relative to parent metal, which may resolve this issue.

Non-Destructive Testing

The higher the service temperature, the greater is the need for the highest quality pipework. In addition, therefore, to all the usual specification tests, it is becoming customary to make use of various forms of non-destructive testing, notably radiography and ultrasonics, both in manufacture of the pipe itself and in examination of the final welded or manipulated pipework. Together with others in this field, Stewarts and Lloyds are actively engaged on non-destructive testing, its development and application. Ultrasonic methods and electro-magnetic methods are being investigated, as well as various other types of specialized testing.

The ideal arrangement is to have some means of testing the pipe continuously as it is produced from the mill or at other stages during manufacture, and to a large extent this type of quality control is being achieved.

Both seamless and welded tubes can be examined ultrasonically during manufacture and afterwards for flaws, cracks and other imperfections. Special jet probes have been developed for this purpose and, with these, the major difficulty of ensuring good coupling between the crystal generator of ultrasonic pulses and the work to be examined is largely overcome. With these probes, two continuous streams of water run from the ultrasonic crystal " heads " to the work; one stream introduces the pulses into the work and the other returns the reflected signals. Much information can thus be obtained as to the type and degree of any weld flaws, and an automatic marking device shows their location.

For welds joining pipe to pipe, it has long been the custom to use radiography to determine whether the welds are sound. As well as using X-rays, Stewarts and Lloyds were among the first to use the gamma-rays from radioactive isotopes. In consequence they have developed a number of special techniques in the use of isotopes, particularly with regard to safety. Even in the examination of joints between pipes, ultrasonic, electro-magnetic and penetrant methods are being used increasingly.

Much research is still needed in non-destructive testing and it is becoming evident that many of the earlier claims regarding such testing equipment are exaggerated. It is, for example, particularly difficult to determine the depth of a surface crack, since much depends upon its orientation and whether or not it penetrates the surface. In any case, there is no agreement yet as to the importance of the type of flaws that can be detected by non-destructive testing. Since the method is a particularly sensitive one, it would seem that in many cases material perfectly capable of doing the job may be rejected for some alleged defect. Thus non-destructive testing, though a very useful tool, must be intelligently applied, with due regard to the service for which the pipe is to be employed.

Design Considerations

Even assuming that the required pipe can be produced with a full knowledge of its high temperature behaviour, it is necessary to translate this into a practical design basis. In effect this means that the required design stress for any given design temperature must be determined. Not only must the required life of the pipework be known, but also the probable mode of failure, the required formula for relating creep tests and design stresses, and the factors of safety.

There are numerous other matters which enter into the design. For example, since flanges are still used to a limited extent in modern power stations, their design is constantly under review. The welding of branches into pipes is another subject of research, and particularly the reinforcement of branch pieces to compensate for the weakening of the pipe at a junction. Pioneer work on branch reinforcement was undertaken by Stewarts and Lloyds many years ago and is still reviewed from time to time.

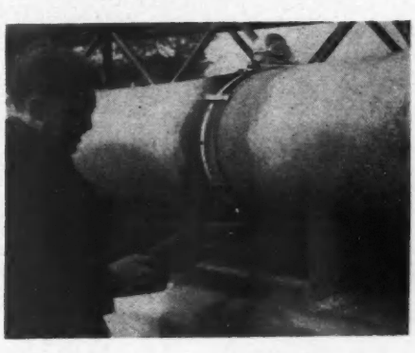
An interesting recent development, though not perhaps strictly research, is that the calculations of the flexibility of power station pipework, which are very laborious and time-consuming, are now carried out very rapidly indeed by the use of a " Leo " computer at Corby, so much so that Stewarts and Lloyds find it worthwhile to send calculations from their South African and Australian companies to be worked out in this country. Australian results can be in their hands within eight days, of which seven-and-a-half are taken up in transit.

Future Requirements

It is evident that steam pressures and temperatures will continue to rise, particularly in the nuclear power field. Even now, temperatures are such that pipes made of ferrous materials have to be inordinately thick and costly. It may well be that, if temperatures rise much higher, entirely different materials may have to be considered, first perhaps the heat-resisting non-ferrous alloys, such as the nimonics, and ultimately perhaps ceramics, cermets or other materials, such as those used in space research.

One promising proposal, often put forward but never much developed, is that the thermal insulation should be *inside the pipe* so as to keep the pipe itself cool enough to be made of conventional materials.

This Research Report refers to only one firm's research activities on high temperature pipework. Similarly work is, however, being done by others in the industry.



Radiography of welded tubular joint by gamma-rays.

XUM

Heating and Ventilating

The size of the Heating, Ventilating and Air-conditioning Exhibition (Hevac) to be held at Olympia, London, from 26 September to 6 October, is an indication of the growth of such installations during recent years. While most of the exhibits are intended primarily for industrial users, there is still quite a high number that are intended for the purely domestic application.

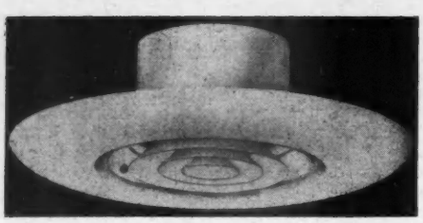
The first illustration shows an air diffuser—the Airmaster—one of a series made by the Fairitt Engineering Company Limited, 101 Sandford Road, Moseley, Birmingham 13. This is a universal purpose model and is fitted with adjustment for the air delivery that can alter the pattern from stratification at upper levels to direct delivery to the floor level for various ranges of temperature. Operation of the adjustment can be by local or remote control. A simpler version is also made which is intended to meet the requirements of smaller installations where the larger version would be unnecessarily expensive. Available for fitting behind the diffuser is an iris damper for discharge control, the advantage being that the discharge is always centralized to the diffuser for all settings of the damper. Complete shut-off is obtainable and the noise level is reduced on closing.

Air extraction is the complement of air intake and an example is the Xpelair window mounting fan shown in the second illustration. This is a 12 in model in the wide range made by Woods of Colchester Limited, Braiswick Works, Colchester, who also make aerofoil fans, silencers and heat exchangers. The 12 in model illustrated will move 60,000 cu. ft of air per hour and the direction of flow can be reversed by either turning the mains socket connection through 90° or by means of a remote reversing controller which will also regulate the fan speed. The Xpelairs are fitted with a built-in draughtproof iris shutter linked with a built-in fan switch.

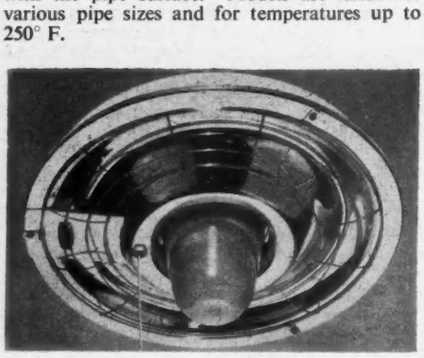
Another extractor fan is made by Rolco Engineering Limited, 407 Hornsey Road, London N19. The standard model is designed for easy fixing and consumes only 20 watts—that is, it will run for approximately 50 hours for one unit of electricity. It is a very compact unit measuring only 4½ in diameter by 4 in deep and the air displacement is between 3,000 and 4,000 cu. ft per hour. Switching is automatic and is controlled by a nylon cord which also combines the control of the variable air intake.

A unit which combines heating and lighting is the Heat'n'Light produced by Thermair Domestic Appliances Limited, Izons Lane, West Bromwich, and shown in the upper right illustration. It consists essentially of a central light with an annular silica-sheathed heating element. The light is controlled from the normal wall switch and the heater by a pull cord. The unit is suitable for installation in the bathroom as well as in kitchen, hall or garage and complies with safety requirements when mounted on the ceiling. There are no surface wires, so that the unit is flush mounting leaving a clean appearance. The heat from the element is radiated by a circular polished aluminium reflector which gives an overall diameter to the unit of 16 in. The maximum depth, including the light shade, is 6½ in. The standard model is designed to operate from 200-220V or 230-250V mains, ac only, and the element is rated for 750 watts.

Designed particularly for domestic applications, a new version of a spring fitting thermometer is available from the British Rototherm Company Limited, Merton Abbey, London SW19. The instrument is arranged to clip directly to either vertical or horizontal water pipes using a spring that fits on two of four hooks according to the angle of the pipe. A soft copper saddle ensures good thermal contact with the pipe surface. Models are made for various pipe sizes and for temperatures up to 250° F.



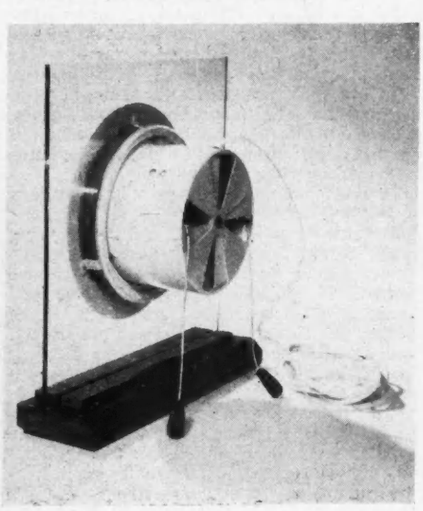
(*Above*) *Air diffusion patterns are adjustable in the Airmaster unit.*



(*Above*) *The Thermair Heat'n'Light combines a central lamp with an annular heating element.*

(*Below*) *Up to 60,000 cu. ft of air per hour can be extracted by the 12 in Xpelair fan.*

(*Below*) *For small rooms, the Rolco extractor fan is only 4½ in diameter.*



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